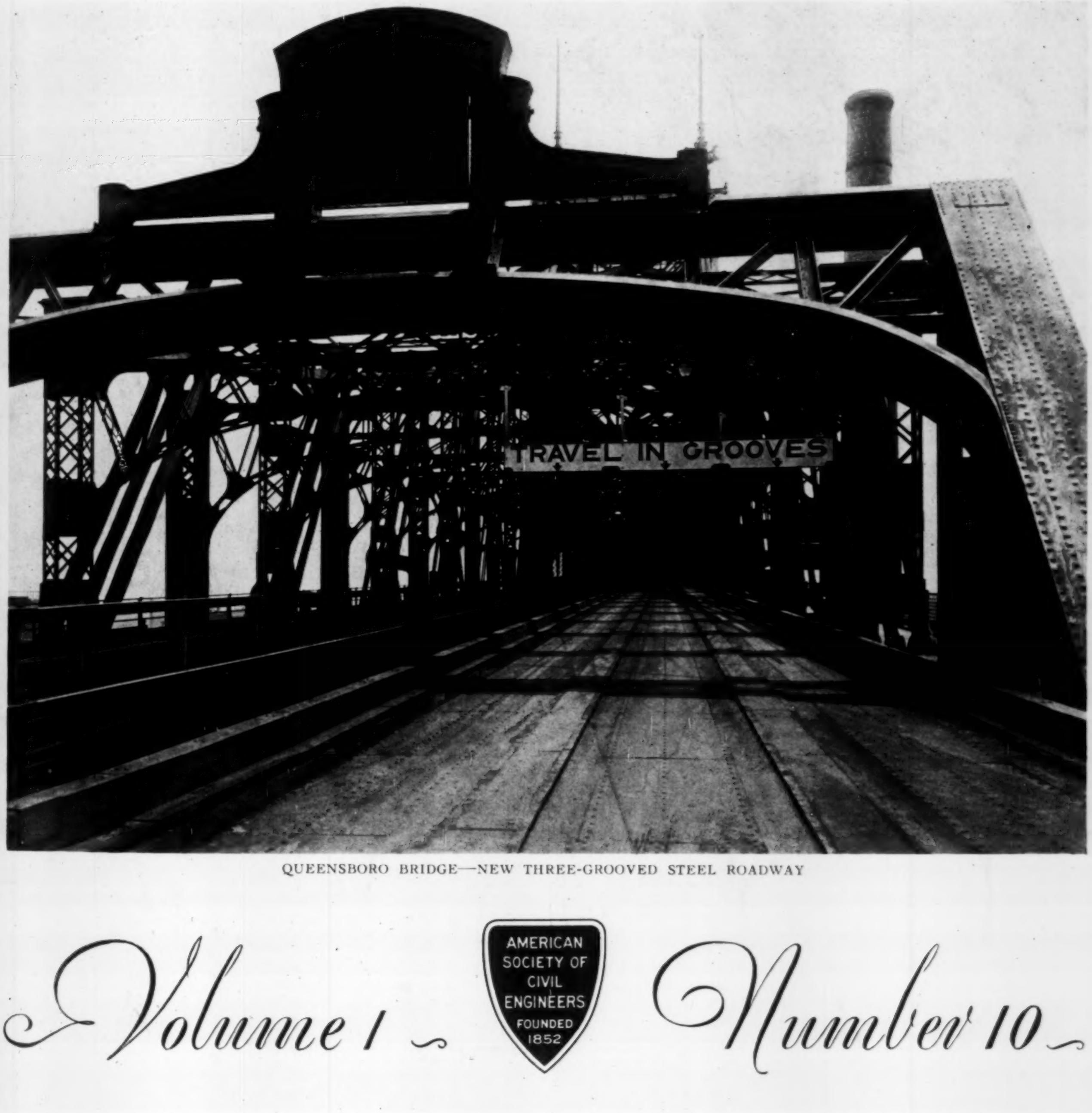
.5
56 Engs

CIVIL ENGINEERING

Published by the
American Society of Civil Engineers

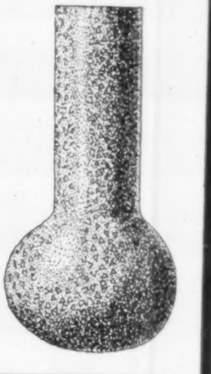


QUEENSBORO BRIDGE—NEW THREE-GROOVED STEEL ROADWAY

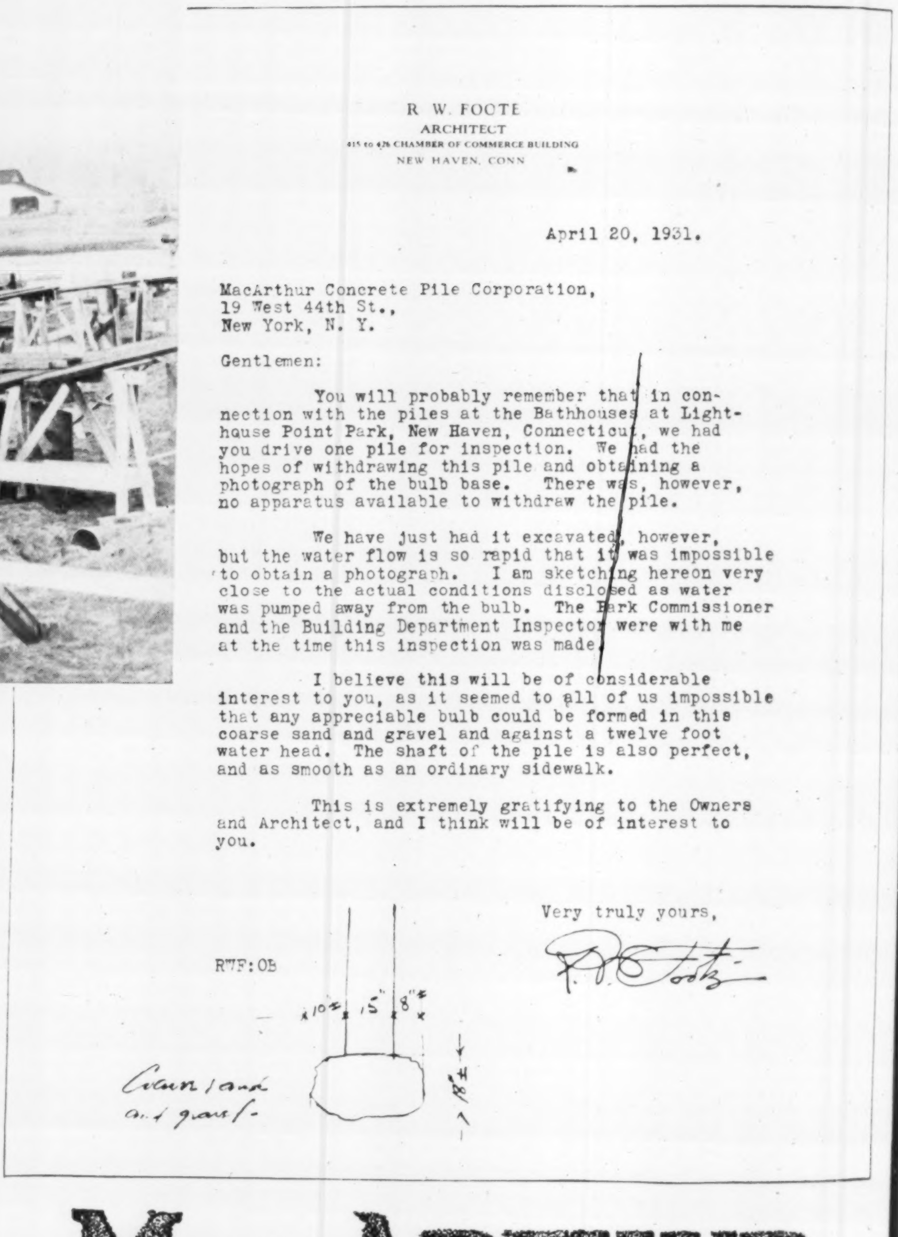
Volume 1 AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 10*

JULY 1931

We drive *every* *type* of pile . . The Pedestal Pile was needed *here* . . .



MacArthur rig driving MacArthur Pedestal Pile at Lighthouse Point Park, New Haven, Conn.



R. W. FOOTE
ARCHITECT
615 to 626 CHAMBER OF COMMERCE BUILDING
NEW HAVEN, CONN

April 20, 1931.

MacArthur Concrete Pile Corporation,
19 West 44th St.,
New York, N. Y.

Gentlemen:

You will probably remember that in connection with the piles at the Bathhouses at Lighthouse Point Park, New Haven, Connecticut, we had you drive one pile for inspection. We had the hopes of withdrawing this pile and obtaining a photograph of the bulb base. There was, however, no apparatus available to withdraw the pile.

We have just had it excavated, however, but the water flow is so rapid that it was impossible to obtain a photograph. I am sketching hereon very close to the actual conditions disclosed as water was pumped away from the bulb. The Park Commissioner and the Building Department Inspector were with me at the time this inspection was made.

I believe this will be of considerable interest to you, as it seemed to all of us impossible that any appreciable bulb could be formed in this coarse sand and gravel and against a twelve foot water head. The shaft of the pile is also perfect, and as smooth as an ordinary sidewalk.

This is extremely gratifying to the Owners and Architect, and I think will be of interest to you.

Very truly yours,

RWF:OB

Check your requirements against MacArthur qualifications:

Product	*proven*
Experience	*21 years*
Equipment	*latest*
Resources	*unlimited*
Personnel	*capable*
Clientele	*illustrious*
Responsibility	*demonstrated*
Engineering	*sound*
Performance	*100%*
Speed	*record-breaking*

MacARTHUR
CONCRETE PILE CORPORATION

19 WEST 44th STREET, NEW YORK, N. Y.

Branch offices
CHICAGO NEW ORLEANS PITTSBURGH CLEVELAND BOSTON DETROIT
PHILADELPHIA SOUTH JACKSONVILLE, FLA. BUFFALO WASHINGTON, D. C.
CANADIAN MacARTHUR CONCRETE PILE CO., Ltd., MONTREAL

Giles Drilling Corporation (an affiliated company) will welcome the opportunity to submit estimates on core borings or soundings of any description.

THE BRIDGE BUILDER

by Will Allen Dromgoole in "Rare Old Chums", Page Company, Boston, Mass.

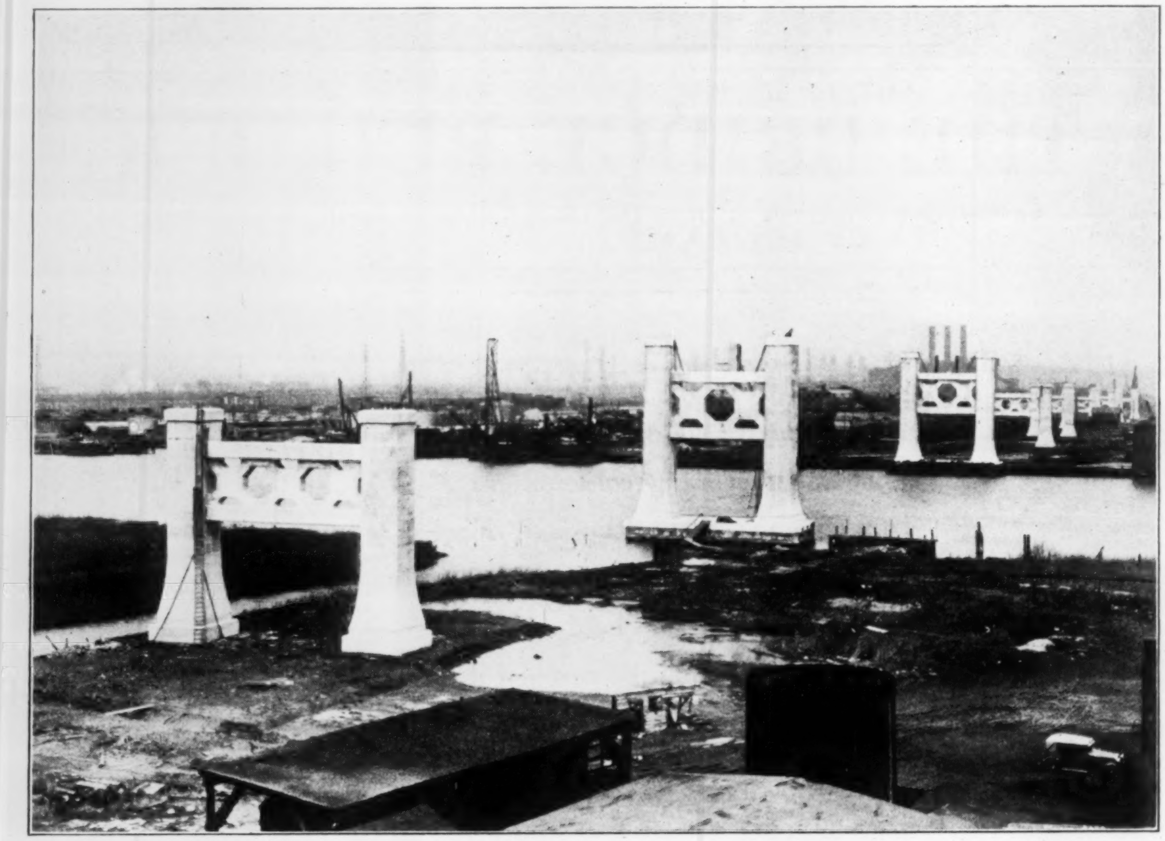
An old man, traveling a lone highway,
Came at the evening, cold and gray,
To a chasm vast and deep and wide.
The old man crossed in the twilight dim,
For the sullen stream held no fears for him,
But he turned when he reached the other side
And builded a bridge to span the tide.

●

"Old man," cried a fellow pilgrim near;
"You are wasting your strength with building here.
Your journey will end with the ending day
And you never again will pass this way.
You have crossed the chasm deep and wide,
Why build you this bridge at eventide?"

●

And the builder raised his old gray head,
"Good friend, on the path I have come," he said,
"There followeth after me today
A youth whose feet will pass this way.
This stream, which has been as naught to me,
To that fair-haired boy may a pitfall be.
He, too, must cross in the twilight dim,
Good friend, I am building this bridge for him."



PIERS FOR PASSAIC RIVER CROSSING—LINCOLN HIGHWAY KEARNY, N. J.

TOPS OF RIVER PIERS ABOVE WATER LEVEL—94 FEET
CLEARANCE OF BRIDGE ABOVE WATER LEVEL—135 FEET
ALL PIERS CARRIED TO ROCK BY PNEUMATIC METHOD

Built For

NEW JERSEY STATE HIGHWAY COMMISSION

By

THE FOUNDATION COMPANY

NEW YORK
ATLANTA PITTSBURGH CHICAGO

FOREIGN OFFICES

LONDON
PARIS
BRUSSELS

ROME
ATHENS
TOKYO

CARTAGENA
LIMA
LA PAZ

SANTIAGO
BUENOS AIRES
MONTEVIDEO

Industrial Plants - Warehouses - Railroads and Terminals - Foundations - Underpinning
Filtration and Sewage Plants - Hydro-Electric Developments - Powerhouses - Highways
River and Harbor Developments - Bridges and Bridge Piers - Mine Shafts and Tunnels

Among Our Writers

George K. Burgess continued his scientific work in Paris, where in 1901 he earned a Doctorate in Science. Both Case School of Applied Science and Lehigh University have honored him with the degree of Doctor of Engineering. Beginning his career with the Bureau of Standards in 1903, Dr. Burgess has been its director for the past seven years.

John H. Chase has had charge of the development of construction and operation of the wells, pipe lines, and pumping plants of the Riverside Highland Water Company, Calif., for a number of years and has been the engineer for other large users of power for irrigation.

M. H. Gerry, Jr., has spent an active lifetime in the design and operation of properties, mainly hydro-electric, railway, and power, and has been chief engineer and consulting engineer for projects in Minnesota, Montana, Idaho, and Washington. Since 1925 he has maintained consulting offices in San Francisco.

Herbert J. Gilkey has recently been selected to head a newly organized department of theoretical and applied mechanics at Iowa State College. He is considered an expert on concrete, in which he has conducted a vast amount of research. As a member of the Board of Consulting Engineers on Concrete Problems, he is advising the Government on the construction of the Hoover Dam.

Warren Raeder, since graduation from the University of California in 1916, has had a varied experience in structural engineering, mostly in St. Louis. For the past five years he has been on the staff of the Civil Engineering Department at the University of Colorado.

Anson Marston is best known for his long connection with Iowa State College, where he is Dean and Director of the Engineering Department. In addition, an active consulting practice in highways, bridges, water supply, and drainage has brought him into contact with many important projects. As a member of the Interoceanic Canal Board, he has advised the Government on the Nicaragua Canal and the enlargement of the Panama Canal, and has recently returned from an inspection of the latest Nicaraguan route.

Mark B. Morris obtained his engineering education under Dean Marston at Iowa State College, where he graduated in 1921. After a number of years on highway and valuation work in Iowa, he took up his present work of research in materials for use in highway construction by the Iowa State Highway Commission.

Edward A. Byrne has to his credit 45 years of service for the City of New York. He has been the head of the engineering forces of the Department of Plant and Structures since 1915. Owing to his specialized experience, he was called into consultation on the Holland Tunnel and on the Philadelphia–Camden Bridge.

Leroy C. Smith was formerly Deputy Commissioner and Chief Engineer of the State Highway Department of Michigan. After nine years of service for that organization, in 1918 he was appointed Engineer-Manager for Wayne County, Mich. Under his direction expenditures for highways, bridges, grade separations, and rights-of-way have grown to $10,000,000 annually.

Volume 1 Number 10

July 1931

Entered as second class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912.

Copyright, 1931, by the
American Society of Civil Engineers
Printed in the U. S. A.

CIVIL ENGINEERING

Published Monthly by the
American Society of Civil Engineers
(*Founded November 5, 1852*)
Publication Office: 20th and Northampton Streets, Easton, Pa.
Editorial and Advertising Departments:
33 West 39th Street, New York

This Issue Contains

The Bridge Builder 907

The National Hydraulic Laboratory at the Bureau of Standards 911
George K. Burgess

Cheap Power from Natural Gas 917
John H. Chase

Safety Limitations of the Hoover Dam 921
M. H. Gerry, Jr.

New Formula for Concrete Columns Needed 924
Herbert J. Gilkey
Warren Raeder

A Century of Progress in Civil Engineering 929
Anson Marston
Mark B. Morris

Increasing the Vehicular Capacity of Manhattan's Bridges 933
Edward A. Byrne

Detroit Builds Highways for the Future 939
Leroy C. Smith

Our Readers Say 944

Society Affairs 955
En Route for Tacoma; A Program for the Power Division; Information for Society Authors; Engineering Council Committee Report; Another Milestone; Assistance in Chinese Research Work; Proceedings and Transactions Summer Schedule; New Division Looks Ahead; Appointments of Society Representatives; Committee on Earth and Foundations Reports; Student Prize Winners

Items of Interest 963
Civil Engineering for August; Alloys of Iron Research; A Humanitarian Movement; Coming Events; Honorary Degrees for Members; Valuable Rainfall Data; First Steam Railroad in the United States to Be Scrapped; Single Court of Patent Appeals Proposed; Testing Apparatus Shown; Verein Deutscher Ingenieure; Reappointment of Freeman Scholar

News of Engineers 965

Membership—Additions and Changes 966

Men and Positions Available 968

Recent Books 970

Current Periodical Literature 972

Index to Advertisers 980, 984

The Society is not responsible for any statements made or opinions expressed in its publications.

Reprints from this publication may be made on condition that full credit be given Civil Engineering, *the author, and date of publication.*

Subscription Rates

Price, 50 cents a Copy; $5.00 a year in advance; $4.00 a year to Members and to Libraries; and $2.50 a year to Members of Student Chapters. Canadian postage 75 cents and foreign postage $1.50 additional.

1. Bitumuls Armor Coat, used to salvage old pavement. Los Angeles County, Calif. — San Pasqual Ave., near Pasadena.

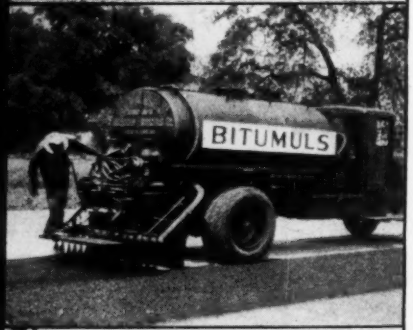
THE MODERN WAY TO USE ASPHALT

• ● • ● •

for durable wearing surface, armor coat, full penetration pavement, cold pre-mix, road mix, retread, and maintenance —

Paving engineers throughout the country have acclaimed this new and better way to use asphalt. Extensively used all over the world. No heating.. applied cold, with simple equipment .. at any temperature above freezing, or in mildly wet weather. Durable. No shoving, bleeding or corrugating. Insures a smooth-riding, permanently non-skid surface. For complete facts on "The Modern Way to Use Asphalt" write for a set of Bitumuls Bulletins. American Bitumuls Company, Dept. 1, 200 Bush St., San Francisco.

2. Coarse rock, ready for rolling and Bitumuls application.



3. Applying Bitumuls cold, with ordinary distributor truck.

4. Spreading screenings on fresh Bitumuls application, to be followed by rolling and brooming.

Bitumuls Armor Coat, with its non-skid surface texture, and absence of later bleeding and fat spots, shoving and rhythmic corrugations, is the best value in the road building market.

BIT-U-MULS

Factories and Offices: BOSTON, BALTIMORE, CINCINNATI, ST. LOUIS, BATON ROUGE, LOS ANGELES, PORTLAND, ORE. *Executive Office:* SAN FRANCISCO

Francis Lee Stuart
President
George T. Seabury
Secretary
Sydney Wilmot
Manager of Publications
Walter E. Jessup
Editor

CIVIL ENGINEERING

Committee on Publications
Charles H. Stevens
Chairman
Henry R. Buck
L. G. Holleran
Edward P. Lupfer
Ole Singstad
W. L. Glenzing
Advertising Manager

Volume 1
July 1931
Number 10

The National Hydraulic Laboratory at the Bureau of Standards

By George K. Burgess

Director, Bureau of Standards, Washington, D.C.

After nine years of continuous and energetic effort initiated and fostered by John R. Freeman, Hon. M. Am. Soc. C.E., the United States is soon to see the completion of a National Hydraulic Laboratory. With a main flume to carry from 250 to 300 sec-ft., and numerous pumps, it will contain provisions for circulating more than twice the volume of water available in any other laboratory under cover. As Dr. Burgess states, the laboratory is the result of the best thought that is available among eminent hydraulicians both here and abroad. Those who have relentlessly worked for the consummation of this enterprise deserve the thanks of the entire engineering profession. Its cost will be returned many times over in the economies resulting from the tests and studies to be carried out in it. It will be available about March 1932.

Hydraulic engineers have come to realize more and more during the last decade that further advancement in hydraulic engineering depends to a large degree upon an increasing knowledge of the science of hydraulics, rather than the improvement of the art, and that, owing to the complicated nature of hydraulic phenomena, this end is to be chiefly sought in the hydraulic laboratory. On May 14, 1930, President Hoover signed the bill passed by the Seventy-first Congress authorizing the construction, at the Bureau of Standards of the Department of Commerce, of a laboratory to be devoted to extending our knowledge of hydraulic science and its application to engineering problems.

Development in hydraulic science was greatly accelerated in Europe about the beginning of this century under the lead of Professor Engels of Germany. At the end of the World War the necessity for effecting every possible economy in the design and construction of hydraulic structures in European countries led to the scientific study of their design and thus encouraged the construction of hydraulic laboratories.

Thanks to the progress made by Engels, Krey, Rehbock, Möller, and others, hydraulic engineers in Germany were prepared to accept the method of model tests as yielding reliable information and enabling them to predict the conditions which would obtain in a full-sized structure. Consequently, the use of laboratory methods of research spread rapidly through Germany and extended to other European countries. This European development is very completely set forth in the monumental book, *Hydraulic Laboratory Practice*, edited by John R. Freeman, Hon. M. Am. Soc. C.E.

NEED FOR A NATIONAL LABORATORY

In the United States, however, hydraulics remained more of an art than a science. There was a need not only for more modern methods in hydraulic design, but also for more ample facilities for experimental work. Many of the engineering colleges in this country possessed hydraulic laboratories, but only a few of them were used for any purpose except to instruct students and afford facilities for graduate research.

Several of the Government departments having to do with hydraulic problems—for example, the Bureau of Reclamation, the Bureau of Public Roads, and the Geological Survey—felt keenly the need of an adequately equipped hydraulic laboratory to which they could bring their problems.

NINE YEARS OF EFFORT REWARDED

The movement to establish a National Hydraulic Laboratory in this country was initiated by Mr. Freeman in 1922. His many years of experience in hydraulic engineering made him quick to grasp, on his several visits abroad, the importance of the progressive methods which had spread through the European hydraulic laboratories, bringing about vast improvements in the design and construction of great hydraulic works. Through the medium of the American Engineering Council, he was brought in touch with Senator Joseph E. Ransdell of Louisiana, who was deeply interested in the possibility of utilizing the laboratory method to aid in solving some of the problems of flood control on the Mississippi River.

RESOLUTION INTRODUCED IN CONGRESS

In 1922, Senator Ransdell introduced in the Sixty-seventh Congress a resolution to establish a National Hydraulic Laboratory, and thereby began the campaign to educate Congress, resulting finally in the Hydraulic Laboratory Act of 1930. Hearings were held by the Senate Committee on Commerce in 1922, 1923, and 1924. The House Committee on Rivers and Harbors held two hearings in 1928, eight in 1929, and one in 1930.

From 1922 to 1930, practically the whole of the engineering profession rallied to the support of the proposed legislation. Numerous engineering bodies, headed by the American Engineering Council and the American Society of Civil Engineers, endorsed the project by resolution, and scores of individual engineers wrote to, or appeared in person before, the congressional committees to advocate the passage of the measure.

Engineers from the Bureau of Reclamation and the Geological Survey of the Department of the Interior, and from the Bureau of Public Roads of the Department of Agriculture, testified at length as to the scientific and economic value of such a laboratory and the great assistance which it would be able to give them in designing hydraulic structures, both by improving the design and by reducing the cost of the structures.

The only opposition of any consequence was offered by certain officers of the Corps of Engineers of the War Department, mainly on the grounds "that the laboratory might be used by irresponsible parties to dictate to the Corps of Engineers as to how the work intrusted to its care should be executed....." This opposition sufficed to delay passage of the bill for several years until Major-General Lytle Brown, M. Am. Soc. C.E., became Chief of Engineers. He expressed approval of the measure, thereby removing the last opposition to it.

Before enactment in its final form, the bill passed the Senate three times and the House twice. The appropriation of $350,000 for the construction of the laboratory was carried in the second deficiency bill, signed July 3, 1930. For operation and additional equipment for the fiscal year 1932, Congress has provided $36,880. It is estimated that the annual cost after that date will be about $52,000.

PROBLEMS AWAITING THE LABORATORY

One specific function of the laboratory is basic research to make more exact our knowledge of the flow of water, to seek out new facts, and to determine more accurately values for the many coefficients involved in hydraulic design. Many of these coefficients have been determined only from small-scale tests and should be checked with larger flows of water in order that the effect of scale reduction may be determined, thus giving the designing engineer more confidence in the values which he adopts.

A widely different field of endeavor is the study of the laws of transportation of silt and sediment by rivers, canals, and flumes. A knowledge of these laws is a prerequisite to the successful solution of many river and flood control problems. Much work has been done on this difficult subject, both abroad and in the United States, but as yet we have only touched the surface of the problem.

GOVERNMENT STUDIES TO BE MADE

The laboratory will also be active in studying proposed designs of hydraulic structures for such departments of the Government as may need this help. Such studies will be intended to make improvements in the configuration of particular designs in order to obtain the best and most economical structure for a given service. From tests of an engineering nature, such as these, scientific information may also be obtained—for example, an understanding of the laws which govern scale effect, and a more exact knowledge of the nature of flow.

Numerous specific problems have been suggested by the Bureau of Reclamation, such as the Hoover Dam and the Cle Elum Spillway, and some more general in nature, such as a study of the hydraulic jump on sloping surfaces, of flow in chutes and in transition sections, and a study of means for preventing erosion below spillways.

HYDRAULIC INSTRUMENTS TO BE TESTED

Another phase of the laboratory's work will be the testing and development of hydraulic instruments and accessories. At present the only tests of hydraulic instruments which the Bureau of Standards is equipped to make are calibrations of current meters in still water and tests of water meters up to $1^1/_2$ in. in size. These existing facilities will not be duplicated in the new laboratory, but they will be extended to enable tests of current meters to be made in running water, with or without artificially produced eddies and other types of disturbances. The new laboratory will also make possible the testing of water meters up to 6 in. in size, and of venturi meters, orifice meters, and the like, in moderate sizes.

This laboratory should act as a clearing house of hydraulic information. It should have available the most complete list of references on hydraulics which can be compiled; its staff should be familiar with current hydraulic investigations both at home and abroad; and it should furnish a convenient means of liaison with the foreign hydraulic laboratories.

Routine or special tests of hydraulic instruments and accessories will be made for departments and independent agencies of the Federal Government; for states and their political subdivisions; and also for private individuals and firms on the payment of a suitable fee, providing the necessary facilities for making such tests exist in the laboratory and cannot be found elsewhere. Scientific investigations and model studies of hydraulic structures will be made for governmental agencies up to the capacity of the laboratory.

It is anticipated that arrangements can be made to permit governmental agencies other than the Bureau of Standards to send their engineers and investigators to the Bureau of Standards to work in cooperation with the staff of the laboratory on problems in which they are interested. A similar arrangement, providing for cooperation between the bureau and industry, is already in effect. It is called "The Research Associate Plan," and is described in the Bureau of Standards Circular No. 296. This plan can be extended to investigations in the hydraulic laboratory.

DESIGNED BY MANY EXPERTS

A hydraulic laboratory is one of the most difficult structures to design which can be imagined, since it cannot be planned to meet a single particular problem but rather must be arranged to meet a great variety of problems, the conditions of which can be predicted only in a very general way, and which are continually changing. For this and other reasons it was decided to appoint an advisory committee to aid in the design and program of this laboratory. Various governmental units which have to do with hydraulic problems were asked to designate one representative each, and the American Engineering Council was also asked to nominate several. The committee is constituted as follows:

J. P. Dean, Office of the Chief of Engineers, War Department, Washington, D.C.
Gano Dunn, M. Am. Soc. C.E., President, J. G. White Engineering Corporation, New York, N.Y.
John R. Freeman, Hon. M. Am. Soc. C.E., Consulting Hydraulic Engineer, Providence, R.I.
W. B. Gregory, M. Am. Soc. C.E., Professor of Experimental Engineering, Tulane University, New Orleans, La.
N. C. Grover, M. Am. Soc. C.E., Chief Hydraulic Engineer, U.S. Geological Survey, Department of the Interior, Washington, D.C.
E. C. Hutchinson, M. Am. Soc. C.E., Editor, *Power*, New York, N.Y.
E. W. Lane, M. Am. Soc. C.E., Research Engineer, Bureau of Reclamation, Department of the Interior, Denver; C. A. Bissell, M. Am. Soc. C.E., alternate.
S. H. McCrory, M. Am. Soc. C.E., Chief, Division of Agricultural Engineering, Bureau of Public Roads, U.S. Department of Agriculture, Washington, D.C.
L. F. Moody, Mem. A.S.M.E., Consulting Engineer, Cramp-Morris Industrials, Inc., Philadelphia, Pa.
R. S. Patton, M. Am. Soc. C.E., Director, U.S. Coast and Geodetic Survey, Department of Commerce, Washington, D.C.
B. R. Van Leer, Mem. A.S.M.E., Assistant Secretary, American Engineering Council, Washington, D.C.
S. M. Woodward, M. Am. Soc. C.E., Professor of Mechanics and Hydraulics, State University of Iowa, Iowa City.

William I. Deming of Washington, D.C., was appointed architect.

This committee has held several meetings, the first on June 25, 1930, and the last on December 8, 1930.

At the outset it was realized that the desires of certain members of the committee as to the size of the laboratory, the volume of water to be handled, and the pumping capacity, could not be met within the appropriation of $350,000 for the building and major built-in equipment.

At the meeting of July 15, 1930, the committee recommended the appointment of Professor Woodward as consulting engineer in charge of the hydraulic features of the design of the laboratory. From this time until the final design was completed, Professor Woodward took charge of this work and the hydraulic staff of the bureau worked under his direction. In the summer of 1930, Mr. Freeman, Mr. Gregory, and Mr. Hutchinson, of the committee, and Dr. Briggs of the Bureau of Standards spent several weeks in Europe and brought back their latest impressions for the use of the committee.

Assistance and advice were also obtained from other hydraulic engineers. Contributions to the final design were made by Floyd A. Nagler, M. Am. Soc. C.E., and Frederic T. Mavis, Assoc. M. Am. Soc. C.E., Professors at the State University of Iowa; and recommendations were obtained from others, among them, Fred C. Scobey, M. Am. Soc. C.E., and R. L. Parshall, Assoc. M. Am. Soc. C.E., of the Department of Agriculture; D. L. Yarnell, M. Am. Soc. C.E., of the Bureau of Public Roads; Charles M. Allen, M. Am. Soc. C.E., the Worcester Polytechnic Institute; and R. L. Daugherty, Professor at the California Institute of Technology. Valuable assistance was also rendered by A. C. Chick, of Mr. Freeman's staff. Consequently it can be seen that every effort was made to obtain the best judgment available in the country before the final design was completed.

On recommendation of the advisory committee, certain general features were striven for in the design of the laboratory: maximum flow, free floor space, flexibility of equipment, and large surface area for the supply basins.

LARGE OPEN FLOOR SPACE NECESSARY

Most of the committee felt that it would be desirable to make provision for a maximum flow of 500 cu. ft. per sec. in the main flume, as recommended by Mr. Freeman, if this could be accomplished within the appropriation. The size of the main flume was involved in this recommendation, since a flume 15 ft. wide, with walls 16 ft. high, would be required to take full advantage of this flow.

As much of the work in the laboratory involves the construction of models with special apparatus, it was considered desirable to provide the maximum possible amount of free floor space.

It is impossible to predict the exact nature of the experimental work which the laboratory may be called upon to conduct in the future and it would therefore be undesirable to provide for a "rigid" layout of equipment. Rather it is preferable to provide a minimum of fixed equipment, but ample means for distributing water to all parts of the laboratory so that experiments can be conducted simultaneously from independent water supplies.

It is important to have a large surface area in the supply basins in order to reduce the change in pumping head when the measuring basin is filling, and to remove air bubbles carried by the water returning from experiments.

SEVERAL PLANS DESIGNED AND ESTIMATED

Before the final plan was adopted, however, several individual plans were studied in detail. At the first meeting of the advisory committee, in June 1930, Mr. Freeman presented a plan for the laboratory, providing for a building 414 ft. long, 76 ft. wide in the center, and 102 ft. wide at each end. The dominating piece of equipment was a concrete flume some 250 ft. long, 15 ft. wide and 16 ft. deep, with a capacity of from 500 to 600 sec-ft. A large measuring basin was provided at the lower end of this flume to provide for volumetric measurements up to the maximum flow. Such a building would have a content of over 1,500,000 cu. ft.

Several sketch plans prepared by the hydraulic staff of the Bureau of Standards were much more modest in extent than the one just mentioned, and called for a building having a content of from 600,000 to 700,000 cu. ft. Each of the designs provided for a concrete flume, the largest having a cross section 10 ft. wide by 10 ft. high, and the smallest one 8 ft. wide by 8 ft. high. The maximum flows for which provision was made ranged from 150 to 300 sec-ft.

At a meeting held in New York in January 1931—at which were present several members of the advisory committee; engineers and estimators of the J. G. White Engineering Corporation and of the Turner Construction Company; the architect, William I. Deming; and representatives of the Bureau of Standards—it was finally decided that it was impossible to construct, with the funds available, a working laboratory which would provide for a flow of 500 sec-ft. in the main flume, and that it would consequently be necessary to prepare a compromise design.

The staff of the Bureau of Standards, still working under the direction of Professor Woodward and in coöperation with the architect, then set to work, with the result that the design was completed and sent out for bids on March 5, 1931. After twice advertising for bids, the contract for the building proper, including flumes and basins, was let to Stofflet and Tillotson of Philadelphia for $294,887. Construction started April 23, 1931, and is due to be completed next March.

PRINCIPAL FEATURES OF THE LABORATORY

According to the final plan, the building proper is to be of brick and steel construction, to match architecturally the other buildings at the Bureau of Standards. The substructure is of concrete with footings carried to firm rock in order to reduce settlement to the smallest possible amount. The greatest care was taken in the design of the substructure and water basins and in the specifications for the concrete so that the walls and floors in contact with water may be as free from settlement and shrinkage cracks as possible.

To reduce changes in deflection under varying loads to a very small amount, the floors are of heavy construction. Such deflections would interfere seriously with experimental work, particularly when long models built with accurate slopes were being used.

From its three-story rectangular head (82 ft. long and 93 ft. wide) at the east end, it extends westward for 204 ft. at a height of two stories and a width of 60 ft. Thus the building has a total length of 286 ft. The supply basins at the east end and the measuring basin at the west end extend beyond the limits of the building proper. Including supply and measuring basins, the building has a content of 1,295,000 cu. ft.

Extending under the entire building is a basement, the plan of which appears in Fig. 1. It contains two large supply basins at the east end of the building, with connecting channels 6 ft. wide extending to the opposite end. At the west end there is a tumble bay to take the discharge from the main flume and to carry the water to the several return channels and venturi meter lines, all of which lead back to the supply basins, thus completing the circulation.

LARGE BASIN FOR VOLUMETRIC MEASUREMENT

West of the tumble bay is a measuring basin capable of holding 30,500 cu. ft. of water. This basin can be used to measure volumetrically at least two-thirds of the maximum flow of from 250 to 300 sec-ft. for which provision has been made but it is hoped that it will be possible to enlarge the basin at some future date to make more adequate provision for very accurate measurement of the highest flows of which the laboratory is capable.

Two return pipe lines connecting the tumble bay with one of the supply basins and containing venturi meters for measuring the flow of water, are planned. One of these lines is to be 8 ft. in diameter, and will afford a means of measuring flows up to at least 250 sec-ft. The other line, to be 3 ft. in diameter, will provide for the measurement of flows up to about 60 sec-ft.

There will be a straight run of about 100 ft. of pipe upstream from the venturi meters, so that the flow at the meters should be quite free from disturbances, particularly if straightening vanes are used near the entrance to the pipes. Every effort will be made to provide a layout which will permit of such experimental work as velocity distribution and boundary layer studies, as well as of the accurate measurement of flow.

The floor of the main flume is at the same elevation as the first floor, also shown in Fig. 1. The flume proper is 217 ft. long from the head gates to the tumble bay, and 12 ft. wide. The walls are 12 ft. high from the outlet end to a point about 30 ft. below the gates. From this

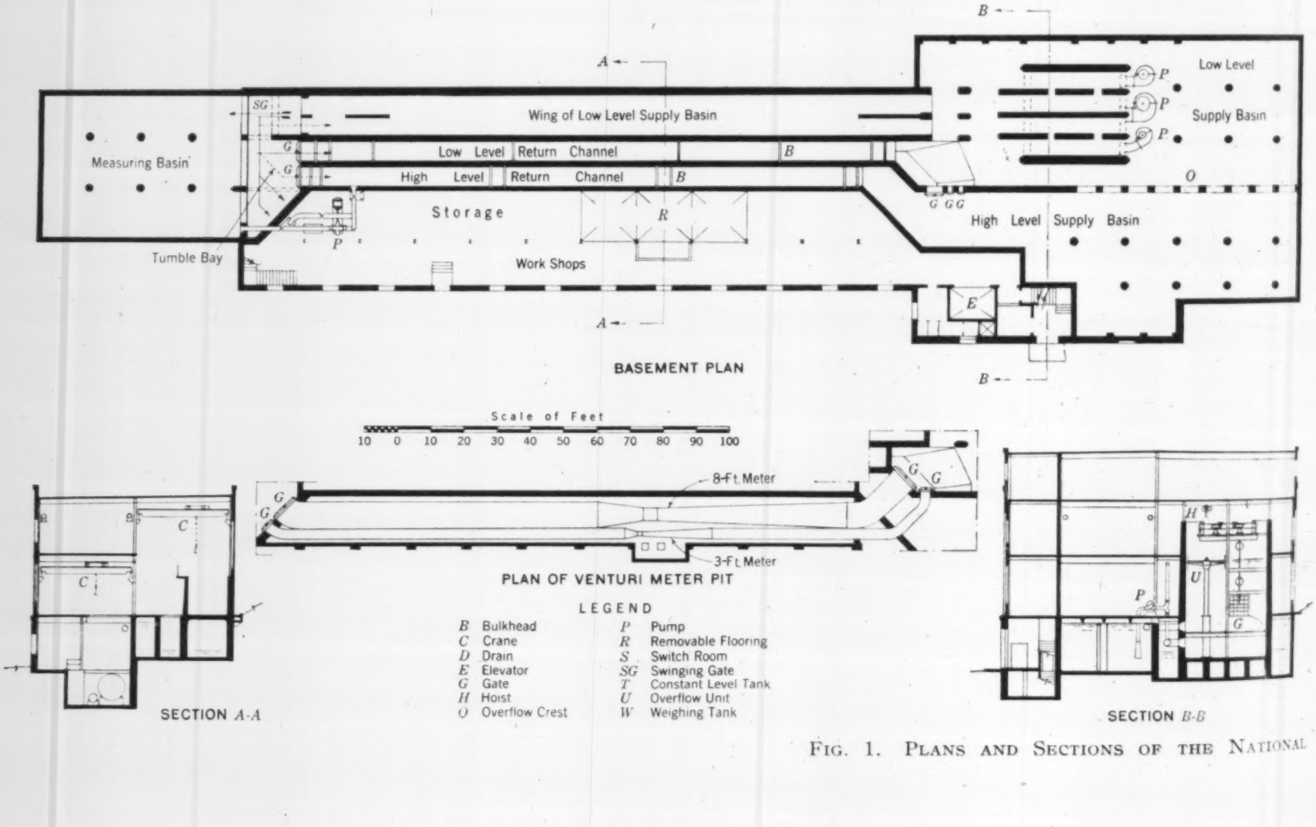

A
A
B
B
Low Level Supply Basin
Wing of Low Level Supply Basin
Measuring Basin
Low Level Return Channel
High Level Return Channel
Storage
Work Shops
Tumble Bay
High Level Supply Basin
SG
G
G G G
B
R
P
O
E
BASEMENT PLAN
Scale of Feet
10 0 10 20 30 40 50 60 70 80 90 100
8-Ft. Meter
3-Ft. Meter
PLAN OF VENTURI METER PIT
C
H
U
SECTION A-A
SECTION B-B
LEGEND
B Bulkhead
C Crane
D Drain
E Elevator
G Gate
H Hoist
O Overflow Crest
P Pump
R Removable Flooring
S Switch Room
SG Swinging Gate
T Constant Level Tank
U Overflow Unit
W Weighing Tank

FIG. 1. PLANS AND SECTIONS OF THE NATIONAL

point to the gates the walls are increased in height to 25 ft.

A number of openings fitted with cast-iron frames are provided in the south wall of the flume, to be closed with steel plates or heavy plate glass as the occasion may demand. Numerous piezometer openings are also provided in the floor of the flume.

PROVISIONS FOR MAINTAINING CONSTANT HEAD

The discharge tank which supplies the flume with water is a rectangular reinforced-concrete structure about 27 ft. sq. in horizontal cross section, with walls extending to a height of 25 ft. above the floor of the main flume. These walls can be increased 4 ft. in height by the addition of a few steel plates, giving a total head of 29 ft. on the floor of the flume. The main supply of water for this tank is furnished by three vertical-shaft submerged centrifugal pumps, having capacities of approximately 50, 85, and 125 sec-ft., respectively. The water is pumped through the openings in the east wall of the discharge tank and passes up through baffles.

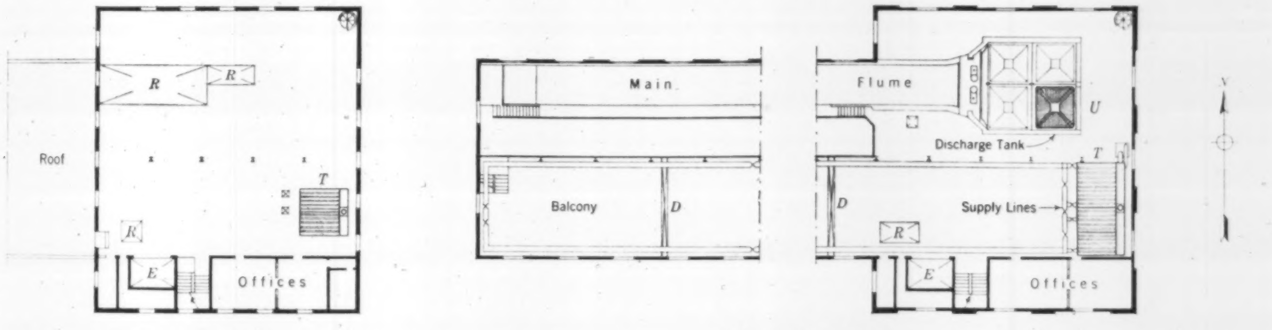
In spite of fluctuations in the pump discharge, the water level in the discharge tank must remain unchanged so that the flow through the flume can be maintained at a constant rate. For this purpose four square systems of overflow troughs are mounted, each at the top of a 22-in. vertical waste pipe leading back to the supply basin, as shown in Fig. 1. These overflow units have a total crest length of about 2,000 ft., so that an appreciable change in pump discharge will produce only a minute change in the depth of the water wasting over the trough crests. These units are to be adjustable vertically, through a range of 25 ft., so that any desired water level within this range can be maintained.

Two electrically operated sluice gates 6 ft. sq. will control the flow into the main flume. Baffles will be mounted in the high walled section of the flume just below the gates, and a measuring weir can be placed there if desired. At the outlet end of the flume, the water will ordinarily fall into the tumble bay, whence it will be returned to the supply basins through the various return channels, as desired. To measure volumetrically the flow in the flume, the water will be diverted to the measuring basin by means of a swinging gate at the outlet of the flume.

SUPPLY BASIN IN TWO PARTS

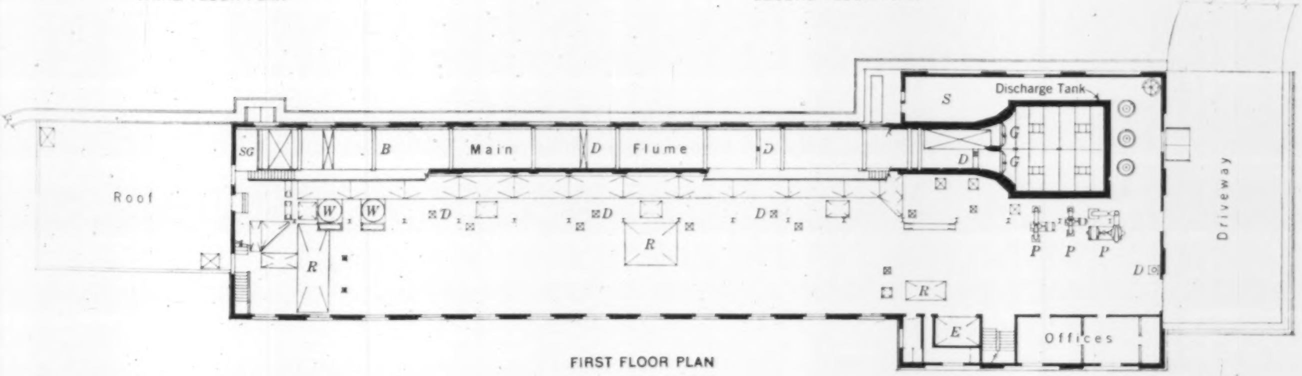
When the flow in the main flume is diverted into the measuring basin, the water level in the supply basin would have a tendency to fall several feet, thus increasing the pumping head and slightly affecting the constancy of the flow in the flume, through the slight change in head on the overflow units. To obviate this condition, the supply basin is to be divided into two parts, and the water level in one maintained about 9 ft. higher than that in the basin from which the large pumps take their suction. By means of a quick-opening sluice gate and two quick-opening valves in the wall between the two basins, a practically constant level, within 6 in., can be maintained in the low-level basin even when the measuring basin is being filled at a flow of 250 sec-ft. This arrangement also has the further important advantage that if one supply basin has to be emptied for repairs to the pumps or other equipment, the laboratory can still be operated at part capacity from the other basin, since the smaller pumps in the laboratory draw their suction from the high-level basin.

On the first floor, near the south wall of the discharge tank, as indicated in Fig. 1, there will be a group of three pumps with capacities of approximately 5, 10, and 20 sec-ft., respectively. These pumps will be used both to supply water to the discharge tank, and to supply, independently of each other, the three compartments of a constant-level tank near the ceiling of the second floor.



THIRD FLOOR PLAN

SECOND FLOOR PLAN



FIRST FLOOR PLAN

Hydraulic Laboratory, Washington, D.C.

A third group of pumps, consisting of two centrifugal pumps of 5 sec-ft. capacity, will be placed on the third floor, where they will supply the two compartments of a constant-level tank near the ceiling of this floor. In order to reduce the pumping head, these pumps will take their suction either from the discharge tank or from one compartment of the constant-level tank on the second floor as desired.

Another pump, with a capacity of from 15 to 20 sec-ft., will be placed in the basement near the west end of the building. It will have three functions: to pump from the tumble bay into the high-level basin, to pump from the measuring basin into the high-level basin, and to pump from the tumble bay into the measuring basin.

The primary means of measuring quantities of water and flows up to about 12 sec-ft. will be provided by two 20-ton weighing tanks arranged in parallel, so that one can be filling while the other empties. It will thus be possible to conduct a measurement continuously over as long a period as may be desired. The large measuring basin will be used to measure volumetrically large flows in the main flume. A series of smaller measuring basins will be provided by inserting bulkheads in the high-level return channel. The bulkheads will be arranged in pairs, with a narrow space between the two members of each pair for the purpose of catching and permitting the measurement of leakage from the basins thus formed. The volumes of all the measuring basins will be determined by direct measurement and by the weighing tanks.

VENTURI METERS FOR MEASURING FLOWS

A third means of measuring flows, both large and small, is provided by the venturi meters. It will be possible to calibrate these meters both by means of the large measuring basin and by a pitot tube traverse; hence it is anticipated that a high degree of accuracy, probably better than 0.5 per cent, will be possible in measuring flows in this way. Secondary means of measuring flows for individual tests will be provided through weirs or orifices. When particular accuracy is required, the weighing tanks will be used for tests conducted on the second floor.

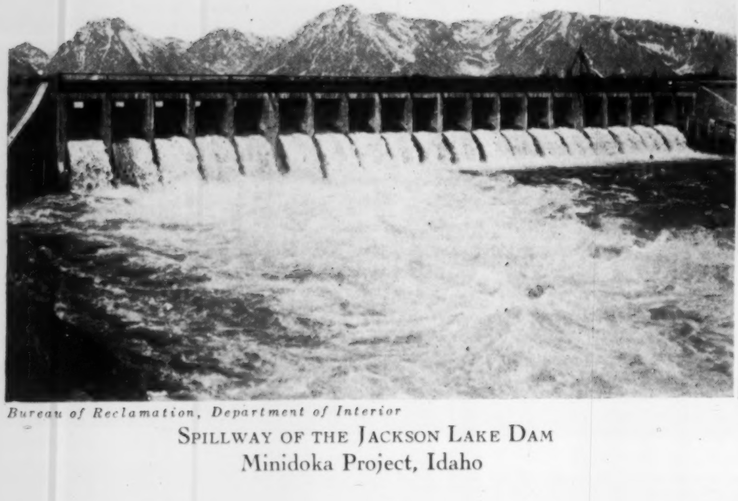
The large amount of unobstructed floor space provided can be seen from the diagram. Flumes, river models, or straight lengths of pipe up to about 240 ft. in length can be built on either the first or second floors. An unobstructed area 44 by 78 ft. is provided on the third floor. In general, tests requiring heavy models and large quantities of water will be conducted on the first floor. Flows of from 50 to 70 sec-ft. can be obtained on this floor outside the main flume. On the second floor, flows up to 35 sec-ft. will be possible, and provision is made for supplying water to several different experiments on this floor simultaneously and independently of each other. The third floor will be reserved for small-scale tests requiring quantities of water, and for tests on wide models of moderate length requiring not over 10 sec-ft. of water.

No definite provision has been made for tests requiring a head of more than about 65 ft., but a temporary tower can be built on the roof at the east end of the building to increase the head if this is necessary. It is hoped that a high standpipe can be erected at some future date to supply this need.

ADEQUATE PROVISION FOR RESEARCH

In the design of this laboratory, advantage has been taken of experience both here and abroad, and it is believed that the requirements of the several governmental field services, as expressed by their representatives, can be met. Provision has been made for circulating more than twice the volume of water in any existing laboratory under cover.

In the design, provision has been made for useful, large-scale, fundamental research, of wide scope and the highest attainable precision, for improving the economy and accuracy of measurements of water by weirs and orifices. Adequate provision has also been made for fundamental research concerning the hydraulic laws governing the flow of water, and for experiments on models with a range in size sufficient to determine scale effects. For the $350,000 available, I believe we shall have a laboratory that will render to the Nation the maximum possible return on the investment.



Bureau of Reclamation, Department of Interior

SPILLWAY OF THE JACKSON LAKE DAM
Minidoka Project, Idaho

ARROWROCK DAM
Boise Project, Idaho

Cheap Power from Natural Gas

Economics of Its Use in Internal Combustion Engines for Pumping Plants

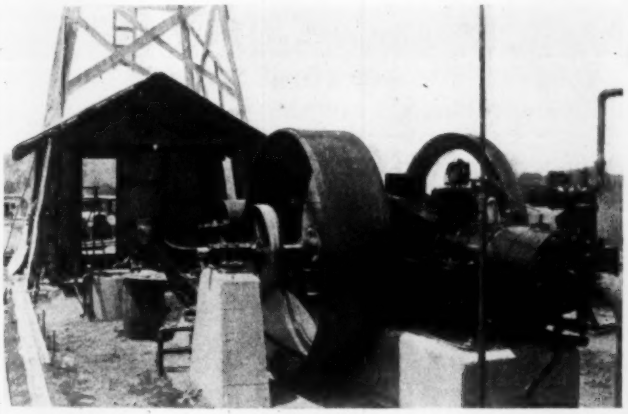
By JOHN H. CHASE
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, RIVERSIDE, CALIF.

KNOWLEDGE of power, its sources, availability, and applications, is an essential part of the equipment of the civil engineer. In the past, natural gas as a source of power has been somewhat neglected in favor of purchased electrical power, and this has been due both to ignorance of its advantages for certain purposes, and also, to some extent, to prejudices against it. The author here discusses reasons for the restricted application of this fuel and gives examples to show in detail the savings which can be effected by its use in internal combustion engines.

As a result of the tremendous growth of the natural gas industry in California and the Middle West, a cheap form of power has been introduced which is certain to be reflected in lower production costs in these regions. Part of the rapid development of industrial processes in Los Angeles can be traced to this source, for natural gas has been available for several years.

The industrial field for power from natural gas lies in its use as fuel in steam plants and in internal combustion engines. Since both of these applications mean expensive installation costs compared with electric motors, it is necessary to make a thorough investigation before entering upon a program of this kind.

Purchased electric power is convenient and presents few problems of operation, so that the average user is prone to follow the line of least resistance until, in many cases, he is forced to the realization that his power bills represent the difference between profit and loss.

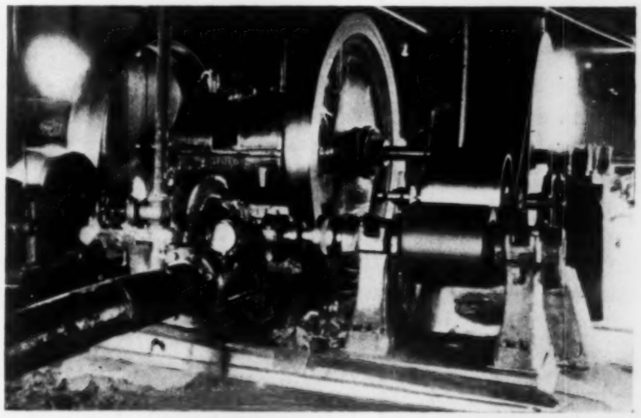

WELL PUMP DRIVEN BY 80-HP. GAS ENGINE
Moreno Mutual Irrigation Company, Beaumont, Calif.

Unfortunately, the average power user is totally incapable of computing power bills, operating expenses, and fixed charges. He is therefore an easy prey to specious arguments to the effect that the maintenance, attendance, and fixed charges incident to the development of power by natural gas more than offset the difference between the cost of purchased power and that of gas.

A plant layout for gas burning equipment is more complicated than for motor-driven installations. The services of a competent engineer are, therefore, of great assistance to the engine manufacturer and the owner in the preparation of an installation. The auxiliary apparatus is of equal importance to the main engines, and should be installed according to a plan prepared in advance. This phase of the matter too often suffers from haphazard methods.

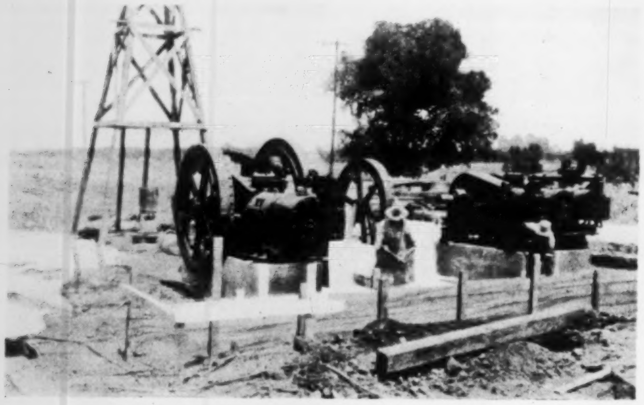
For any type of power plant, the annual costs come under the following heads: fuel or power, lubricating oil, maintenance, attendance, interest on the investment, depreciation, and such miscellaneous items as taxes and insurance.

The cost of fuel and power can be found by consulting the published rates of the utilities serving the section where the plant is located. Sometimes different rates apply, and in this case the lowest should be selected. The amount and cost of the lubricating oil required can be ascertained from actual users or taken at manufacturers' guarantees. Maintenance figures can likewise be learned from actual users. The cost of attendance varies greatly with different installations, but it can be closely estimated from the experience of users. Control planning of the plant, with elimination of the human element, is a great aid in keeping down this expense, and also results in more satisfactory operation.


120-HP. GAS ENGINE OPERATING DEEP-WELL PUMP AND BOOSTER
Clearwater Water Company Pumps in series, lift water 151 ft. to ground level and 230 ft. above, without intervening storage, and synchronize perfectly for all speeds.

In considering the two forms of power here discussed—purchased electric power and that supplied by internal combustion engines using natural gas—the owner must decide whether he will continue to pay high power charges as long as he operates, or whether he will make a large initial investment to reduce his operating expenses.

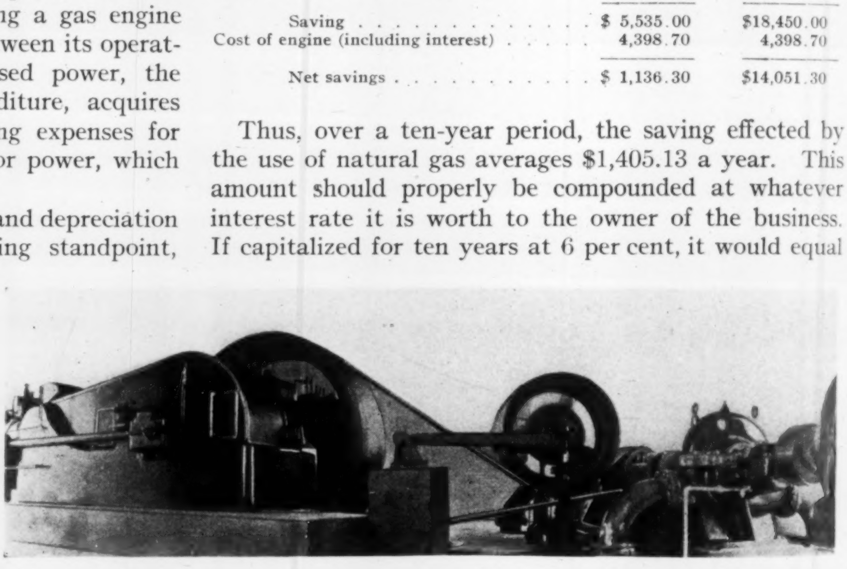
The savings effected by the installation of a gas engine plant should be considered as dividends or returns on the investment, and they should be large enough to cover the amount of the expenditure within a reasonable period. If savings are not sufficient to accomplish this, the owner should continue to use purchased power.



COUNTY LINE PLANT UNDER CONSTRUCTION
Riverside Highland Water Company

Frequently, the operating expenses of the gas engine plus the cost of the engine itself will be no more, over a period of four years, than the cost of purchased power for the same period. In other words, the total charges for both forms of power will be about equal at the end of four years. Therefore, by purchasing a gas engine and paying for it from the difference between its operating expenses and the cost of purchased power, the power user, without additional expenditure, acquires an engine capable of reducing operating expenses for many years, instead of receipted bills for power, which have no value.

Elimination of the charges for interest and depreciation can be made clear, from an accounting standpoint, through the lease method of payment. At the end of the period the contract may be so arranged that the engine can be purchased for the nominal sum of one dollar. This original investment is properly the sum on which interest and depreciation should be charged, for it represents the amount actually required to supply the necessary power. This method will be explained more fully in connection with the following detailed analysis of operating and installation costs.



GAS ENGINE INSTALLATION OF THE ATASCADERO MUTUAL WATER COMPANY, ATASCADERO, CALIF.

The 170-hp. engine operates a two-stage pump to lift water 310 ft. Power from a generator, direct connected to the pump shaft, drives a 35-hp. well pump 500 ft. away. Both pumps operate in series, with perfect starting and synchronization

Consider first the case of a 100-hp. motor used for pumping water continuously seven months each year, the ordinary irrigation duty. The operating expenses incurred for purchased electric power, and for an internal combustion engine burning natural gas, may be tabulated as follows:

ELECTRIC POWER		NATURAL GAS	
Power	$3,850	Natural gas	$1,820
Lubricating oil	5	Lubricating oil	100
Maintenance	10	Maintenance	100
Total operating expenses	$3,865	Total operating expenses	$2,020

The difference in operating expenses for a period of seven months is thus seen to be $1,845 in favor of natural gas. The expenditure for attendance was the same in both cases, this service being performed by a man employed as irrigator.

In this case, the additional investment required for the use of natural gas is $4,000, the cost of an internal combustion engine to supply the amount of power required. This sum can be paid out of the savings effected in operating expenses, $1,845 per year, as shown in the following tabular form:

PERIOD	BALANCE DUE	INTEREST AT 6 PER CENT	SAVINGS IN OPERATING EXPENSES	PAYMENTS
First year	$4,000.00	$240.00	$1,845.00	$1,845.00
Second year	2,395.00	143.70	1,845.00	1,845.00
Third year	693.70	15.00	1,845.00	708.70
Total	....	$398.70	$5,535.00	$4,398.70

The difference between the total savings effected in three years, $5,535, and the total cost (with interest) of the engine, or $4,398.70, constitutes a net saving of $1,136.30. At no time does the annual charge for the new installation exceed the amount which would have been spent for electric power. If the analysis is extended to cover a ten-year period, the amount of savings reaches a much more impressive figure, as may be seen by the following tabulation:

ITEM	FOR THREE YEARS	FOR TEN YEARS
Cost of electric power	$11,595.00	$38,650.00
Operating expenses with natural gas	6,060.00	20,200.00
Saving	$ 5,535.00	$18,450.00
Cost of engine (including interest)	4,398.70	4,398.70
Net savings	$ 1,136.30	$14,051.30

Thus, over a ten-year period, the saving effected by the use of natural gas averages $1,405.13 a year. This amount should properly be compounded at whatever interest rate it is worth to the owner of the business. If capitalized for ten years at 6 per cent, it would equal $18,520, and at 10 per cent for the same period, $22,350.

As the life of a good engine, properly maintained, is much longer than ten years, it is seen that capital charges need not be considered. Strictly speaking, after three years, the extra investment in the gas engine is nonexistent. In 15 or 20 years, when it comes time to buy the second engine, its cost can easily be covered by again setting aside the savings effected for a period of three years, as was done in the case of the first engine.

BOOSTER PUMP INSTALLATION

Consider the case of a larger installation, where there is a deep well, and a booster pump to lift the water from 100 ft. below the surface of the ground to 200 ft. above, a total distance of 300 ft. The installation consists of a 100-hp. gas engine on the well pump, and a 160-hp. engine on the booster. Water is delivered by the well pump to the booster direct, without intervening storage.

An equivalent motor-driven installation would probably consist of a 250-hp. motor on the well pump, without any booster. As the water requirements are variable, it would be necessary to throttle a motor-driven pump for deliveries below the maximum. Gas engines control this condition by change of speed, with little or no loss in pump efficiency, which is always impaired by throttling. The synchronization of the two pumps can be kept in perfect control by varying the speed of the two engines. A pressure of 4 lb. per sq. in. is maintained on the suction of the booster at all times. These exacting conditions would make it very difficult to apply electric drive efficiently at constant speeds. In fact, this consideration is of sufficient importance to warrant the installation of engines, even at the same annual cost as motors.

For the gas engine installation just described, the following operating conditions have been taken from the records of the company:

Month 1929	Water Pumped in Acre-Ft.	Gas Consumed in Cu. Ft.	Cost of Gas	Estimated Kw-Hr.	Cost of Electricity
June	71.0	496,900	$139.13	31,000	$447
July	207.8	1,332,900	373.21	91,000	897
August	169.5	1,142,400	319.87	74,000	778
September	145.3	1,001,900	280.53	64,000	708
October	171.4	1,193,000	334.04	75,000	785
November	173.9	1,070,900	299.85	76,000	792
December	159.2	1,165,200	326.26	69,000	743
Total	1,098.1	7,403,200	$2,072.89	480,000	$5,150

Using natural gas, the operating expenses for the seven-month period are $2,072.89, plus $120 for lubricating oil and $100 for maintenance, making a total of $2,292.89. Subtracting this amount from the sum which would have been spent for purchased electric power, $5,150, the difference constitutes a saving of $2,857.11.

This plant would pay for itself from savings in approximately five years. In 1929, it was operated at 75 per cent of full load. At full load the difference in cost between the two forms of power would be greater, with no increase in capital investment, and the time required to retire the first cost would be correspondingly shortened. It is not strange that this water company has installed some 1,300 hp. in natural gas equipment, since the savings in operating expenses resulting from the use of natural gas throughout the plant amount to $30,000 a year.

GENERATING PLANTS

The generation of electric current by means of gas engines is not so economical as direct applications, because generator, line, and motor losses amount to some 25 per cent of the total. However, generators are used where several motors are involved in such manner that the direct application of engines to the machinery driven is impracticable. At a reasonably good load factor, such a plant will save the amount of its first cost in five years or less. The electrical end of the system has special problems of its own, and the installation of such a plant is more complicated than that of engines for direct application.

A typical generating plant is that of a manufacturing industry with 2,600 hp. in motors of from 100- to 200-hp. capacity. The maximum-demand meter indicates the greatest load for 30 min. to be 953 hp. Therefore, the total capacity of the generating plant need not exceed 1,000 hp. The following is an analysis of the operating cost for this plant for one year, while it was using purchased electric power.

Power Consumption, 1928–1929

Month 1928	Connected Load in Hp.	Maximum 30-Min. Demand in Hp.	Kw-Hr.	Cost
August	2,191 (876.4)	748.00	204,300	$2,777.48
September	2,191	742.00	183,600	2,153.28
October	2,191	820.40	234,900	2,461.08
November	2,191	778.15	218,700	2,363.08
December	2,191	826.40	221,400	2,380.08
1929				
January	2,191	838.50	261,900	2,623.08
February	2,469 (987)	868.63	225,900	2,540.52
March	2,469	856.57	216,900	2,486.52
April	2,469	953.08	236,700	2,605.32
May	2,469	868.63	211,200	2,452.32
June	2,469	868.63	249,600	2,682.72
July	2,469	932.98	290,400	2,927.52
Total (actual bill)			2,755,500	30,453.00
Correction (if consumer had elected to use 1,000-hp. demand				1,852.60
Amount of bill (if demand had been 1,000 hp.)				$28,600.40

The company should have been billed at $28,600.40 by the power company.

The cost of installing a generator and gas engine to supply the same amount of power is estimated as follows:

Items for One Unit	Cost
Engine	$15,000.00
Generator	3,052.50
Exciter	895.00
Alternator	88.00
Pressing on shaft	33.00
Total, f.o.b. factory	$19,068.50
Freight to Los Angeles	1,300.00
Total for one unit	$20,368.50

Items for Three Units	Cost
Three units at $20,368.50	$61,105.50
Cooling tower and installation	11,400.00
3 panels, instruments, and wiring	6,000.00
Total for complete installation	$78.505.50

In estimating the cost of operation with natural gas, it is assumed that 1 kw-hr. is equivalent to 17 cu. ft. of gas. Then the total amount of gas consumed annually will be 2,755,500 multiplied by 17, or 46,843,500 cu. ft. Therefore the operating costs will be:

Item	Cost
46,843,500 cu. ft. of gas, at 21 cents per M	$9,837.14
2,000 gal. lubricating oil, at 25 cents	500.00
Maintenance (2 per cent of $45,000)	900.00
Additional attendance	1,800.00
Annual operating expenses for natural gas	$13,037.14

The annual savings in operating expenses through the use of natural gas will be the difference between the cost of purchased power, $28,600.40, and the operating expenses of $13,037.14, for the gas engine and generator. The annual savings will be $15,563.26.

An investment of $78,500 in a gas engine power-generating plant, such as that discussed in the preceding paragraphs, will return $15,500 annually, or 20 per cent gross. A deduction of 3 per cent for depreciation, to build a fund at compound interest which will replace the plant in 20 years, leaves a net return on the investment of 17 per cent, an attractive dividend. The surplus available in the treasury may permit of the purchase of the plant outright, returning 17 per cent net interest on the investment. If this is possible, it is the best means of financing the installation.

FINANCING THE PLANT BY THE DEFERRED PAYMENT PLAN

If such an investment is not practicable, the plant may be financed by deferred payments, as shown in the following tabulation.

YEAR	BALANCE DUE	INTEREST AT 6 PER CENT	SAVINGS AVAILABLE	POWER BILLS
1	$78,500	$4,710	$15,500	$28,600
2	67,710	4,060	15,500	28,600
3	56,270	3,380	15,500	28,600
4	44,150	2,650	15,500	28,600
5	31,300	1,880	15,500	28,600
6	17,680	1,060	15,500	28,600
7	3,240	195	3,435	28,600
Total		$17,935	$96,435	$200,200

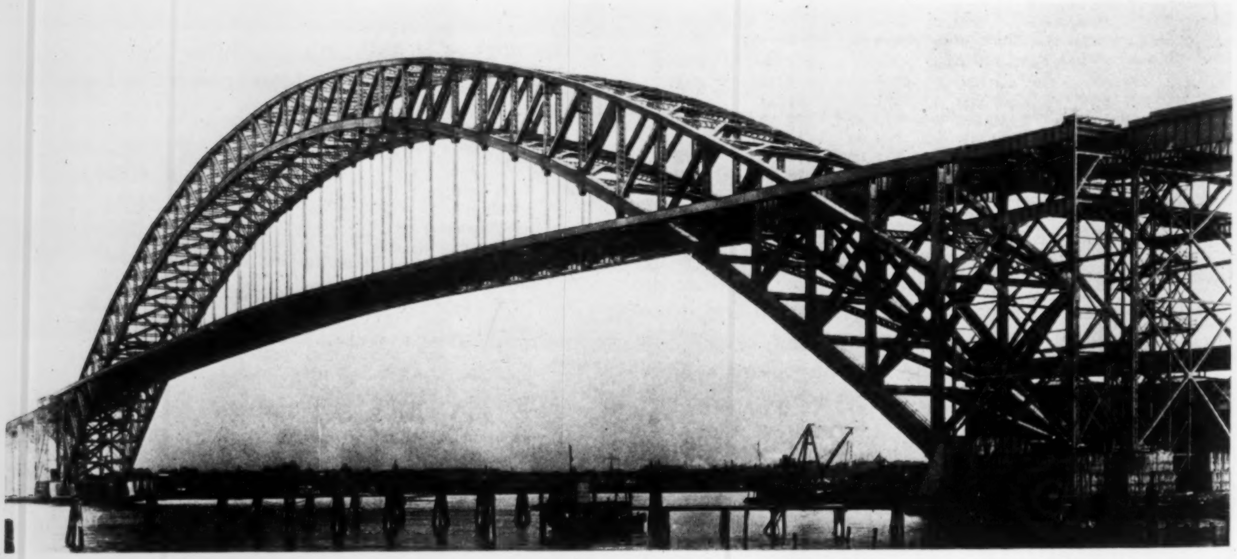
From these data the next step is to compute the net savings effected by the generating plant at the end of seven years, under the deferred payment plan:

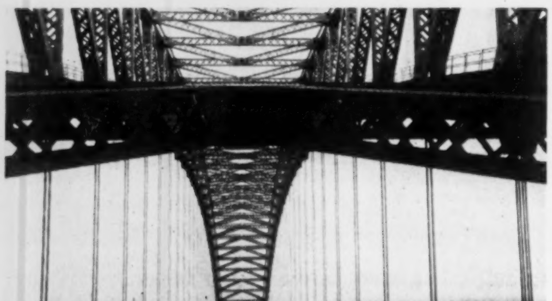
ITEM		AMOUNT
Power bills for 7 years		$200,200
First cost of installation	$78,500	
Interest at 6 per cent	17,935	
Total cost of generating plant	$96,435	
Operating expenses for 7 years, at $13,037.14 .	91,260	
Total 7-year expenditures for generating plant		187,695
Net credit in cash		$ 12,505

If the company continues to set aside each year the saving in operating expenses of $15,500, effected by the use of natural gas, the installation can be retired in less than seven years. Under this plan the company will not be called on to pay any more per year than it would actually pay for power, and in less than seven years it will own the plant outright. Considering the life of the plant to be 20 years, for the next 13 years the savings will amount to $15,500 per year. At 6 per cent compound interest, the total savings would therefore amount to $292,700.

Of course, the possible use of natural gas is by no means universal. Reflection will indicate that there is a proper place for all forms of power—for purchased electric power, and for Diesel, steam, and gas engines. It should be the province of the engineer to determine which of these forms is best for the user.

On account of its low operating costs, I believe that natural gas will in the future receive much more attention from consumers of power than it has in the past.





KILL VAN KULL STEEL ARCH BRIDGE

Since its closure on October 4, 1930, as illustrated on page 183 of the December issue of CIVIL ENGINEERING, rapid progress has been made in the erection of this great steel arch. Progress up to March 25, 1931, is illustrated. The Port of New York Authority (O. H. Ammann, M. Am. Soc. C.E., Chief Engineer) will provide a four-lane highway over the bridge, without sidewalks. Rapid transit tracks can be laid in the future. Twisted wire ropes form the hangers which support the roadway. The bridge is estimated to cost $16,000,000, and, it is expected, will be opened for traffic in 1932. Its location is shown on the map on page 934 of this issue.

Photographs Furnished Courtesy of
THE PORT OF NEW YORK AUTHORITY

Safety Limitations of the Hoover Dam

A Discussion of Stability Against Sliding, of Uplift, and of Arch Action

By M. H. Gerry, Jr.
Member American Society of Civil Engineers
Consulting Engineer, San Francisco

WORK is already under way on the greatest hydraulic structure yet undertaken by man, and the Supreme Court has recently removed the latest legal obstruction. According to schedule, actual excavation for this 730-ft. arched gravity dam will begin in October 1933, and concrete will begin to flow into the forms by the end of 1934. Meanwhile, engineers of the Bureau of Reclamation are continuing investigations of many details of design, and tests on both the celite and celluloid models of the dam, mentioned in the May issue. Recently published discussions on high arch dams show that technical opinion is not in accord on a number of features, notably uplift pressure and the exact effect of arching on the stability of a gravity dam. There is yet time for a beneficial discussion of these moot questions by the profession.

PUBLIC interest in the construction of the Hoover Dam and its related works is so great that a full and free discussion of its essential engineering features in the forum of the Society requires no further justification. In an article published in the October issue of Civil Engineering, Elwood Mead, M. Am. Soc. C.E., U.S. Commissioner of Reclamation, describes the proposed structure, and this information has since been supplemented by detailed specifications issued by the Reclamation Bureau.

In this great undertaking, considerations of safety should come above all else. Of this there can be no doubt, for it is not a question of morals alone, it involves as well the most tremendous financial responsibility. That the Hoover Dam should fail is unthinkable, or that there should exist, after its completion, a justifiable fear for its safety would be a matter of the gravest public concern.

It should not be forgotten that three years ago the massive St. Francis Dam, built by the City of Los Angeles, did fail, and without the slightest warning. Even a cursory examination of the plans now proposed will convince engineers that the Hoover Dam is designed in accordance with the same school of thought and on altogether similar lines. Like the St. Francis Dam, it is deficient in gravity section when uplift is considered; it is curved in plan, on the same radius; and it is designed on the same general theory that some concurrent arch action will take place and thus overcome the limitations of the section—a theory widely disputed by engineers.

A diagram of the St. Francis Dam superimposed on a section of the upper part of the Hoover Dam is shown in Fig. 1. In Fig. 2 is indicated in plan the relative arcs of the two dams at the highest elevation of the masonry. The comparison is of especial interest in view of the fact that the weakest parts of the new dam appear to be the end sections, which have bases founded on the canyon sides at elevations of 300 ft. and less below the crest.

The natural rock at the site is said by the Reclamation Bureau to have good weight-sustaining ability. It consists of tuffs and flows of volcanic breccia and is of a character usually regarded by engineers as irregular and somewhat uncertain until demonstrated to be otherwise by full exposure. Granting that it will be found to have ample strength in compression throughout, this rock is nevertheless by its nature permeable to water, and it has a low coefficient of friction. Prudence suggests a very conservative structure for such foundations.

Furthermore, clear thinking as well as sound engineering dictates that all highly controversial questions, and all assumptions of fact involving the strength and physical characteristics of construction materials, be determined on the side of safety. Also, where a choice is possible in design, as between a determinate and an indeterminate system of support, the decision ought by rights to be in favor of the more certain practice, even at a greater cost.

As Dr. Mead has well said, this project is one of the greatest engineering enterprises in the world today. It is, therefore, of the highest importance that the design be examined in the light of the fundamentals of technical science.

The dam will be nearly twice the height of any now in existence, and it follows that the horizontal water loading per lineal unit of the maximum section will be four times as great. From the published specifications, it is apparent that the effective gross weight of the main structure will be in the neighborhood of 6,800,000 tons, and the maximum total horizontal water pressure, acting in a downstream direction on the projected section of the dam, will be about 3,500,000 tons. These round figures represent, respectively, the total vertical loading on the foundations, and the gross horizontal force tending to move the structure downstream. In the last analysis, they must be sustained at the rock surfaces by reaction to compression and by friction.

As applied to the structural mass, the forces will be redistributed and balanced to some extent by water pressure acting vertically upward on the base of the dam, and horizontally in an upstream direction on that part below tailwater elevation. The normal submergence of the maximum section on the downstream side appears to be about 140 ft. at low water, increasing to perhaps 180 ft. at flood. The uplift pressure, acting above the tailwater elevation, may be taken as full head at the heel, decreasing uniformly to zero pressure at the toe. Determined in this way, the total under-pressure acting upward on the base of the dam is ascertained to be approximately 3,200,000 tons. This amount deducted from the total weight will leave a net unbalanced vertical loading of 3,600,000 tons. The total net horizontal loading acting in a downstream direction, after allowing for the reverse pressure of tailwater, is found to be about 3,400,000 tons.

The computations here given are based on conservative unit weights and pressures, when acting under normal conditions. The figures may be altered to a limited extent by varying the assumptions, but the general allegation of deficiency in respect to resistance to sliding will not be changed. On the other hand, the operation of any one of a number of possible contingencies would produce a most profound effect on the tendency of the dam to slide out of place. Among such contingencies may be mentioned the following: overtopping of the crest from any cause; earthquake shocks; the formation in time of a colloidal sludge exerting a greater pressure than water; the occurrence of severe vibrations due to a high rate of tunnel discharge; and the development of local pressure-head zones within the rock forming the canyon walls.

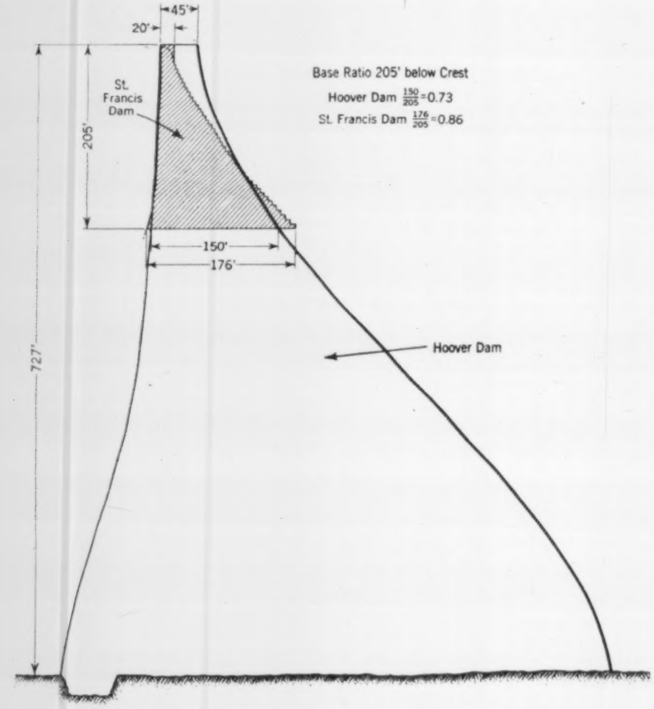

45'
20'
St. Francis Dam
205'
727'
150'
176'
Base Ratio 205' below Crest
Hoover Dam $\frac{150}{205}$=0.73
St. Francis Dam $\frac{176}{205}$=0.86
Hoover Dam

FIG. 1. COMPARATIVE PROFILES OF HOOVER AND ST. FRANCIS DAMS

It follows then that the sliding factor for the structure as a whole will be $\frac{3,400,000}{3,600,000} = 0.94$. This coefficient is based on the action of the dam as a monolith, and it is the most favorable assumption for resistance to sliding. It would be quite impossible, however, for this dam to continue to act as a unit up to the point of final rupture. The end sections would yield first, as a result of the large added loading transmitted to them by torsion from other parts lower down and nearer the center of the structure. The St. Francis Dam yielded in this way, and the Hoover Dam would undoubtedly fail initially at the ends, in a similar manner. Also, when radial sections are analyzed separately, higher sliding factors are indicated toward the ends, and a slightly lower factor at the center.

It is fundamental that a mass depending on friction for support will move out of place whenever the sliding factor is greater than the coefficient of friction for the surfaces in contact. A dam of gravity section is such a mass, and regardless of its strength as a structural unit, it remains in place solely by reason of reactions resulting from friction at or near the foundations. The coefficient of friction is a factor of experiment and is uncertain to a degree. In the April 1930 issue of PROCEEDINGS (Papers and Discussions), page 872, Allen Hazen, M. Am. Soc. C.E., stated:

"There is reason to think that the friction of masonry on some rocks and of the rocks on themselves may be much less than has been commonly supposed—and much less than would be prudently assumed for granite and other hard rocks."

From the many tests made during the past century, this coefficient of friction has rarely, if ever, been found to exceed 0.75 for rock or masonry surfaces under favorable conditions. And it has often been noted as less than 0.5, especially for hard rock or planes of cleavage. As the sliding factor for the proposed Hoover Dam is thus found to be far greater than the coefficient of friction under any conditions, it follows that the structure will be unstable as a gravity section and must have additional support if it is to remain in place.

Obviously, this secondary support is intended to be derived from arch action. To attain such a result, the load must divide at the right time and in correct proportion, and travel through alternative paths to separate rock supports developing coordinated elastic reactions. If the necessary amount of additional support does not develop as and when required, then the structure will yield at the weakest point, and will ultimately fail, as did the St. Francis Dam.

There never has been a rational solution of the problem of indeterminate support for arched gravity dams; nor is there likely soon to be one, for the primary reason that the complex distribution of stresses through so great a mass, involving reactions of cantilever and arch, and the large variability of the modulus of elasticity, are controlled in major extent by the physical attributes of the concrete and rock, the very elements of which are as yet unknown.

By the testing of small-scale models many attempts have been made in the past, and are now being made, to appraise certain features of dam construction. In all such experiments heretofore recorded, the assumption has been that the structures were permanently and immovably fixed at the base, and the models have been so constructed as to produce this condition in fact. Thus there has been eliminated in advance from the investigation the most uncertain element in design and the greatest weakness in actual construction as now practiced.

Many of the results obtained from model tests are of engineering interest as bearing on the fundamental relationships of stress and strain within the limits of the experiments. But as dependable indications of the general security and safe performance of the particular structures under consideration, such model tests are of little practical value.

At the present time, only unsupported opinion contends that arch action may be relied upon with certainty to relieve any considerable deficiency in a dam of gravity section. The more rational view is that a gravity section should be designed as such, with full allowance for uplift, and without dependence on any secondary means of support.

If, then, judgment is based on what is believed to be the consensus of conservative engineering thought—if the existence of full uplift at the heel, and at least the uncertainty of concurrent arch action is admitted—the inevitable conclusion is that the Hoover Dam, as at present planned, has no known margin of safety.

In the April 1930 issue of Proceedings (Papers and Discussions), on page 868, B. F. Jakobsen, M. Am. Soc. C.E., made this pertinent statement: "The writer can only insist that the factor of safety of a dam should be a calculable quantity and not something which is assumed; and he cannot agree to assume that arch action, in general, has certain beneficial qualities, unless these can be shown to exist and their magnitude calculated."

It has, of course, been contended in some quarters that hydraulic under-pressure does not exist, or that it may be overcome at the base of a dam by cement grouting and drainage. Technical opinion, however, in large majority does not concur with such views, but maintains that uplift is always present near the base, and that for safety it should be assumed as full head at the heel with zero pressure at the toe.

Also in the April 1930 issue of Proceedings (Papers and Discussions), page 873, H. de B. Parsons, M. Am. Soc. C.E., made this statement: "All reported observations under actual dams show the pressure of uplift. Uplift would seem to be an actual force, like gravity or reservoir water pressure. Recorded observations show that grouting under the upstream edge of the base does not eliminate uplift, and the assumption that it will is not founded on fact."

Likewise, it is quite generally admitted that, although cement grouting of the rock, with drainage, may control ordinary leakage of water through cracks and fissures, nevertheless these precautions are unavailing in preventing the general distribution of water pressure throughout the interstices of the rock and concrete, and the resulting uplift at the base and at other points where structural nonconformity exists.

SAFETY FACTOR NOT UNDERSTOOD

This accounts for the apparent confusion found at present in the minds of engineers and the public regarding the safety factor claimed for this dam. In the article by Dr. Mead, in Civil Engineering, previously referred to, it is stated that the design is such that the maximum compressive stress in the concrete will not exceed 30 tons per sq. ft., and by inference this is presented as a measure of the safety of the structure. Nothing, however, could be further from the truth. While this stress limit is conservative, it cannot in any way establish the over-all safety of the dam, because stress in the masonry is not the controlling factor.

It is a well known fact that any gravity dam of substantially triangular section, with a base of more than 0.75 of its height, will yield—by sliding out of place under sufficient water loading—long before over-stress can develop in the concrete. The Hoover Dam is a case in point, for considered as a gravity section, its factor of safety against sliding is less than one, although the stated stress for the concrete might be thought to indicate a safety factor of perhaps ten. Such misconception is unfortunate and ought to be cleared away in the interests of a better understanding of the risks involved.

An examination of the plans and specifications, as published by the Reclamation Bureau, shows that unusual and elaborate precautions are proposed for controlling the temperature rise to be expected from the setting of the cement, and for regulating many details of its placement and handling. For a Government structure of such importance, a procedure of this kind can be justified, but only if it is accompanied by consistent thoroughness in other respects. The fact should not be overlooked that even the greatest care exercised in the manipulation of materials or in the details of construction, cannot overcome fundamental deficiencies in design.

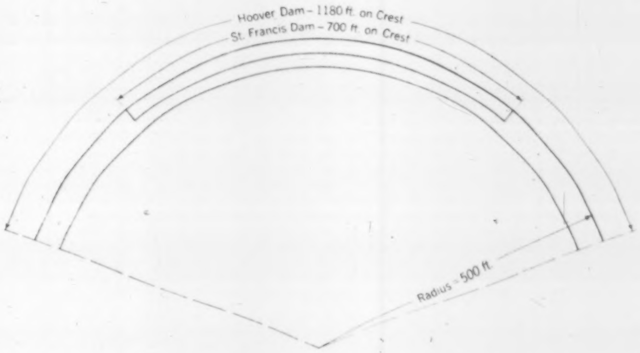

Hoover Dam - 1180 ft. on Crest
St. Francis Dam - 700 ft. on Crest
Radius - 500 ft

Fig. 2. Comparative Crest Dimensions
Hoover and St. Francis Dams

DANGER NOT FROM INTERNAL OVER-STRESS

There is nothing whatever to indicate that this dam might fail by reason of normal over-stress in the concrete, or on account of cracks and minor imperfections in the masonry. The danger lies not within the structure itself, but in the extent and the manner of support to be derived from the foundation rocks. It is there that improvement is essential if adequate safety is to be obtained.

In this brief statement no attempt has been made to discuss technical matters not directly related to the hazard involved. The important and outstanding facts are that the Hoover Dam, as now planned, not only is not a stable gravity section, but also is without any ascertainable margin of safety from secondary support.

Furthermore, this situation is unnecessary and avoidable, because a gravity section can be so designed as to provide, with reasonable certainty, a fixed and safe limit to the risk. The added cost to secure a high degree of safety may perhaps be as much as five million dollars; but it is not too much to pay for security in this case. Rightly considered, this sum is but a trifling percentage of the total related investments, and its expenditure would be warranted as financial insurance, if for no better reason.

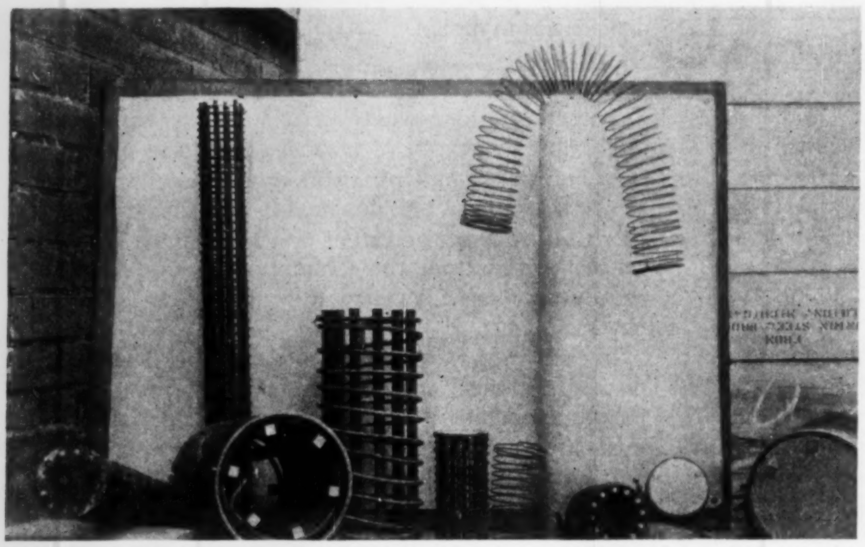
New Formula for Concrete Columns Needed

Results of Recent Tests on Reinforced Concrete Specimens

By HERBERT J. GILKEY AND WARREN RAEDER
MEMBER AND ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PROFESSOR AND ASSISTANT PROFESSOR OF CIVIL ENGINEERING
UNIVERSITY OF COLORADO, BOULDER

Two peculiarities of concrete, its tendency to shrink when drying, and to flow under sustained load, are particularly important in connection with the design of reinforced concrete columns. What effect do these characteristics have on the relative stresses in the steel and concrete, and on the ultimate strength of the columns? What is the result of spiral reinforcement and of bond between the reinforcing steel and the concrete? Designers have long been looking for a solution of these problems. The reconnaissance tests conducted by Professors Gilkey and Raeder, here described, indicate possible answers to these questions and assist in pointing the way to the ultimate development of a new formula for the design of columns of this type.

REINFORCED concrete has long been accepted by the engineering profession, and with it whatever idiosyncrasies it may have. These are now being studied in order to diminish their interference with the usefulness of the material. In connection with the reinforced concrete column, two of these qualities have been attracting the increased attention of the profession during the past 15 years or more, and are now occupying the spotlight in the very extensive program of column tests in progress at Lehigh University and at the University of Illinois, under the sponsorship of the American Concrete Institute. These qualities are: (1) shrinkage, which accompanies drying out; and (2) plastic flow, or the tendency to flow, or to continue to yield, under sustained stress. Much information has recently been obtained in regard to these two qualities, their effect on the stresses in the reinforcing bars, and on the safety and serviceability of the column as a unit.



FORMS AND FABRICATED REINFORCEMENT FOR TEST SPECIMENS

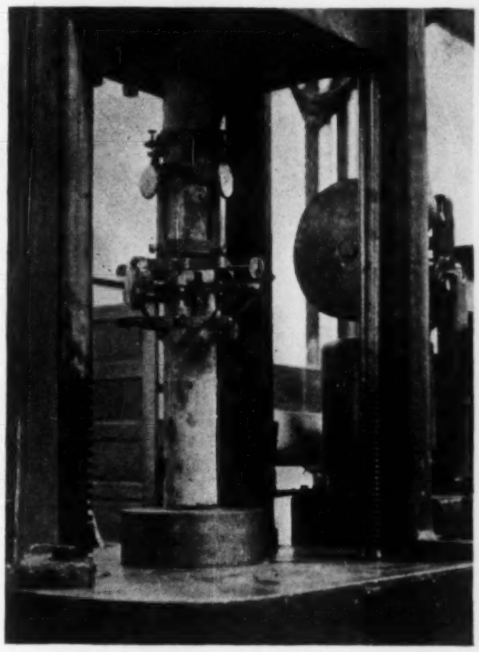
In the publication of the *Verein Deutscher Ingenieure*, Vol. 56, Berlin, 1912, Otto Graf has published the results of observations covering a period of six years and showing the difference in contraction between plain concrete bars and similar bars with steel embedded in them. The specimens were 20 cm. (7.87 in.) square and 1 m. (39.37 in.) long. Those of plain concrete contracted a total of 0.512 mm. (0.0201 in.) at a decreasing rate, when cured in air for a period of six years. Those in which had been embedded a steel bar of an area equal to 3.16 sq. cm. (0.49 sq. in.) contracted 0.225 mm. (0.0088 in.).

Evidently the normal shrinkage of the concrete was reduced by the presence of the steel. The result of this restraint was to put the steel in compression and the concrete in tension, thus causing what has been aptly called a "family quarrel," uninduced by any force outside the specimen itself. The total tension and total compression are in equilibrium and constitute a state of internal stress.

In the steel of Graf's specimens, the stress was 3,300 lb. per sq. in. at the end of three months, 6,000 lb. per sq. in. after one year, and 6,750 lb. per sq. in. at the end of six years, assuming that the modulus of elasticity was 30,000,000 lb. per sq. in.

At the Engineering Experiment Station of the University of Illinois, in 1921, a study was made of the stresses in reinforced concrete specimens resulting from shrinkage, as described in the university's Bulletin 126. The specimens were 6 by 6 in. in cross section and 24 in. long. The concrete mix was 1:2:4. Three different percentages of reinforcing steel were used: four $^1/_4$-in. rounds supplied 0.5 per cent; four $^3/_8$-in. rounds, 1.23 per cent; and four $^1/_2$-in. rounds, 2.18 per cent. The specimens were allowed to dry in air of a humidity varying from 40 to 80 per cent for 99 days. During this period compressive stresses in the steel, and tensile stresses in the concrete increased. In the specimen having the lowest percentage of reinforcing, the steel was stressed to a maximum of 18,000 lb. per sq. in.; and in the specimen with the highest percentage, the concrete reached an average tensile stress of 250 lb. per sq. in.

It follows from these data that, due simply to the shrinkage of the concrete and before any external load is applied, compression is set up in the steel well above the design stress intended for it. The concrete grips the steel, and in shrinking puts itself in tension and the steel in compression. When an external load is applied, the stress in the steel is further increased and that in the concrete remains appreciably less than was probably intended in the design formula. This re-alignment of load distribution between the two materials is one of the two factors comprising what is often referred to as the "unloading" by the concrete of part of its share of the load onto the steel.



A Miniature Column Ready for Testing
Reinforcing Bar Projects at Ends
of 3- by 24-In. Specimen

The extent of this unloading due to shrinkage varies with the percentage of longitudinal steel, as might be expected. The smaller the percentage of reinforcement, the greater the compression in the steel; and the greater the percentage, the greater the tension in the concrete.

EFFECTS OF PLASTIC FLOW

The "time yield" or "plastic flow" also tends to increase the compressive stress in the longitudinal reinforcement of compressive members. Although plastic flow is not a property that is restricted to concrete, it is more in evidence in such materials as concrete, brick, wood, and cardboard than in a substance like steel, at ordinary temperatures.

Some of the earliest published reports concerning plastic flow date back to 1907, when W. K. Hatt, M. Am. Soc. C.E., Professor at Purdue University, tested 8- by 10-in. beams 9 ft. long, and found that the deformation at the end of six months was $2^1/_2$ times what it had been when the first observation was taken. Most of the earliest investigations were conducted on beams. But in 1921, in the *Proceedings of the American Concrete Institute,* Franklin R. McMillan, M. Am. Soc. C.E., and M. B. Lagaard reported measurements on columns in a building at the University of Minnesota which indicated that, in the case of two columns at the age of one and one-half years, the steel reinforcing had been stressed to extreme values of 27,000 and 36,000 lb. per sq. in. These same columns showed stresses of 36,000 and 45,000 lb. per sq. in. at the age of six years. These stresses were computed by measuring deformations in the steel and multiplying by the modulus of elasticity. They were the result of shrinkage and direct axial load, as well as of flow.

A recent report by R. E. Davis, M. Am. Soc. C.E., and H. E. Davis, Jun. Am. Soc. C.E., of the University of California, published in the *Journal of the American Concrete Institute,* for March 1931, gives data on flow and shrinkage effects on plain and reinforced concrete specimens. Observations covering a period of 18 months showed a stress in the steel of the reinforced specimens of 30,300 lb. per sq. in., made up as follows:

Stress	Lb. per Sq. In.
Due to direct load..................	5,700
Due to flow.........................	11,400
Due to shrinkage....................	13,200
Total stress..................	30,300

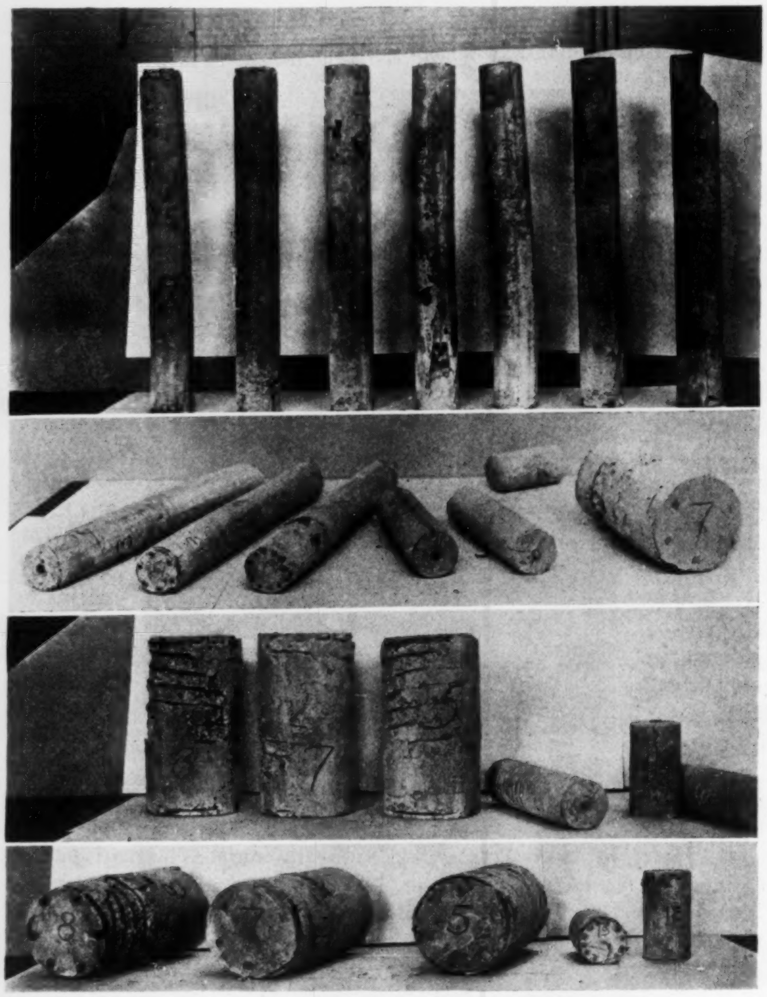
In this case, the stress due to flow and shrinkage combined was over four times that due to the load. Although the steel, which was structural grade, was initially loaded to considerably less than the usual design stresses, it had developed a stress equal to about three-fourths its yield-point strength, and more than double that permitted in the design of structural steel columns.

By far the most extensive work on the subject of shrinkage and flow in columns is being carried on at the present time by Committee 105 of the American Concrete Institute. In all, 573 columns have been made and are now being tested. Of these, 216 have been assigned to an investigation of shrinkage and flow. They are 8 in. in diameter, 5 ft. long, and of three different strengths of concrete. They were kept in moist storage for five days after pouring and then loaded continuously with loads designed on the basis of the American Concrete Institute's Joint Building Code, or, in some instances, in accordance with the code of the City of New York. Some of the specimens are being kept in moist storage and some in air storage.

A recent progress report, which appeared in the *Journal of the American Concrete Institute* for March 1931, gives results of observations covering a period of five months under sustained loading. For specimens kept in air storage, stress in the steel increased between 60 and 75 per cent, in the case of those with a high percentage of steel, 6 per cent. For specimens having only 1 per cent of steel, the stress in the steel increased 200 per cent, and in one extreme case it increased 300 per cent. The highest stress recorded—the result of load, shrinkage, and flow combined—was 42,700 lb. per sq. in. on a specimen in which the steel received a stress of 11,700 lb. per sq. in. from the external load. Probably the yield-point stress of this steel, 49,500 lb. per sq. in., has since been reached. Many of the stresses were above 30,000 lb. per sq. in. The columns had been designed for steel stresses varying from 7,000 to 16,000 lb. per sq. in., with the majority ranging from 10,000 to 12,000 lb. Specimens being held in wet storage show a much smaller increase of stress in the steel—some have even less stress than when the load was originally applied, indicating that the swelling of the concrete has more than offset the effect of flow.

STEEL ASSUMES INCREASING LOAD

Thus, as a result of flow in reinforced concrete columns as well as of shrinkage, the concrete may be thought of as unloading its share of the total external load on the steel. As long as the steel is not stressed to the yield point, its deformation under the load is elastic. It is at a definite rate, equal to the unit stress divided by the modulus of elasticity, and it is constant. The concrete behaves differently; the deformation it assumes is plastic. As the load is applied, the concrete deforms instantaneously but, instead of holding that deformation, it continues to yield or "flow," without any increase in load. Thus, with the steel stable and the concrete yielding, the steel is forced to assume an increasingly greater load.



TYPICAL SPECIMENS AFTER TESTING
Except for No. 7, All Reinforcing Projected from the Ends of the Specimens Before Testing

Until stressed to its own yield point, the steel continues to take additional load. Then it also starts to flow, but due to its relatively large deformation at this stress and to the fact that the flow in the concrete is at a decreasing rate as time passes, the steel takes no additional load. This can be definitely stated. The concrete has unloaded as much of its burden as possible, and any additional deformation, from any cause whatever, must cause the concrete to resume some of its obligation.

When this condition has been brought about, uncertainty is bound to arise. To what extent can the column withstand load if the steel is stressed to its yield point? It is known that steel flows at this stress, and that a structural steel column would fail if so loaded. Will the steel bars in a concrete column also fail, or will they bring about some condition in the column which will make it unsafe? Is the stiffening effect of the concrete, or of the concrete and the spiral combined, sufficient to bolster up the steel and insure the safety of the whole member?

Another question arises in connection with the usual column formula:

$$P = f_cA[1 - (n - 1)p]$$

This formula is based on the assumption that steel and concrete take stresses in proportion to n, the ratio of their moduli of elasticity. The stress in the steel is assumed to be n times that in the concrete. This ratio has been shown to be approximately true when the column is new. But as soon as shrinkage and flow set in—as they do almost immediately after the column is poured—the situation changes, as has been shown. The concrete starts to shrink and flow, and the stress in it decreases, while that in the steel increases. There is no longer a definite relation between the two stresses—certainly no simple relation, as assumed in the formula. Where do we stand, then, with our column formula?

In a large measure it is these questions which have supplied the stimulus for the considerable amount of attention now being given to the reinforced concrete column. Without attempting to encroach on the field which is being so thoroughly covered by the investigations of Committee 105 of the Concrete Institute, the writers, with the help of W. H. Thoman, Assoc. M. Am. Soc. C.E., also a member of the engineering faculty of the University of Colorado, launched a brief program of reconnaissance tests on miniature columns, approaching the subject from a somewhat different angle.

Specimens were cast with the reinforcing bars protruding from the ends, as can be seen in the photograph of the specimen in the testing machine, so that there would be no question but that the steel would be definitely stressed to the yield point. The purpose was to observe the action of the columns under these circumstances.

TYPES OF REINFORCED CONCRETE SPECIMENS TESTED

Specimens were of three sizes: (1) 6- by 12-in. cylinders, some with a single $^1/_2$-in. square bar along the axis (with and without spiral reinforcement), and some with six bars, $^1/_2$-in. square at the periphery, with spirals; (2) 3- by 6-in. cylinders, with a single $^1/_2$-in. square bar, with and without spirals; similar cylinders with six $^1/_4$-in. round bars (p = 4 per cent), and some with twelve $^1/_4$-in. round bars (p = 8 per cent); (3) 3- by 24-in. cylinders reinforced in the same way as the 3- by 6-in. specimens.

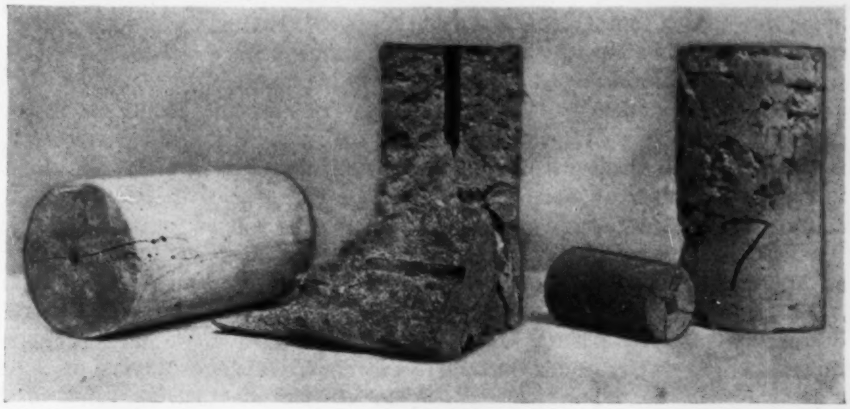
All the bars had milled ends, and all were longer than the concrete cylinders, except in the case of one 6- by 12-in. specimen which had the bars ground flush on the ends. Some bars were greased and wrapped with greased paper to prevent bond. Also there were control specimens, some of plain concrete and some with spiral reinforcing only.

Bars for the 6- by 12-in. cylinders were $^1/_4$ in. and $^3/_8$ in. longer than the specimens. The $^1/_4$-in. bars for the small cylinders were 0.10 in. longer. During testing, no trouble was experienced from the bending of the protruding ends before contact was made with the concrete. In all instances they seemed to simply sink into the concrete until they became flush. Of course permanent set was taken by all the steel before the head and weighing table of the testing machine came into contact with the concrete. Most of the steel bars were from $^1/_2$ to $^5/_8$ in. shorter after testing than before. The load was applied continuously to failure, except for interruption for the purpose of examining the specimens. No attempt was made to apply sustained loading. Both lateral and longitudinal stress-strain measurements were taken on most of the cylinders.

The behavior of the specimens was observed particularly at three stages of the testing: (1) at the yield point of the steel; (2) at the yield point of the specimen—that is, while the specimen was deforming without appreciable increase in load; and (3) after failure. Results may be summarized as follows:

1. All the specimens reinforced with spiral steel were in excellent condition when the stress in the steel reached the yield point. Even after the bars had been squeezed down into the concrete, cracks and spalling which occurred in some of the specimens were purely local. The 6- by 12-in. cylinders showed tangential and circumferential cracks (with a total deformation of $^1/_2$ in.) after they were tested to failure, but the 3- by 24-in. specimens, which more nearly represented actual column proportions, showed no cracks and very little spalling. The concrete core was in very good condition.
2. The 6- by 12-in. specimen, No. 7, with the bars flush and greased, which is illustrated, showed no cracks whatever even after failure. It was in better physical condition after the test than the other 6- by 12-in. specimens, due probably in great part to the fact that the concrete did not have to withstand the jamming effect of pushing the protruding bars into the concrete. Almost all specimens with greased bars took ultimate loads higher than corresponding specimens with ungreased bars, although the difference was slight.
3. In the case of the 3- by 24-in. specimens reinforced with 4 per cent longitudinal, and 1.4 per cent spiral, steel (capable of taking a design load of 11,600 lb., according to the American Concrete Institute formula), the yield point of the steel was reached at 13,000 lb., and the ultimate strengths of the two specimens, at loads of 37,400 lb. and 40,800 lb., respectively. These last figures are equivalent to somewhat more than the ultimate strength of the plain 3- by 24-in. cylinders plus the yield-point strength of the steel. At no time did circumferential or radial cracks develop. The types of failure are illustrated.
4. All specimens without spiral reinforcement showed definite longitudinal cracks at the yield point of the steel, or very soon after. Even though in some cases additional deformation was taken, very slight additional load was sustained. This was true of both 3-in. and 6-in. (diameter) cylinders with a single $^1/_2$-in. square bar in the center.

These experiments show that, unless a column has proper spiral reinforcement, it will crack when the stress in the steel is near the yield point. The crack will extend through at least 3 in. of concrete and can be expected to go farther. Any column may fail under these conditions. This case covers the tied column, that is, the column reinforced at intervals with a hoop or band, but without continuous spiral reinforcement.



EFFECT OF SPIRAL REINFORCEMENT
Typical Splitting of Unspiraled Columns; No. 7 Has Spiral Reinforcement

SPIRAL REINFORCEMENT IMPORTANT

In columns adequately reinforced with spirals, however, the longitudinal steel can be stressed to the yield point without danger of failure. The concrete of the short, stocky, 6- by 12-in. cylinders, with a ratio of $L:D$ of 2, in which the reinforcing bars were longer than the concrete, received greater punishment in the testing machine than it would have in a building, even at the same load, and yet it was in good physical condition after the test. The 3- by 24-in. specimens, with a ratio of $L:D$ of 8, reinforced with 4 per cent of longitudinal steel and 1.4 per cent of spiral, took a load at the yield point of the steel which was one-third of the ultimate on the column. In other words, after the yield point was reached, the specimen took twice that much additional load before it failed. At the yield point there was then a factor of safety of three.

A factor of great importance in the spiral column, however, is the spiral itself. It backs up the concrete in its stiffening effect on the steel and takes the lateral thrust of the steel as it attempts to buckle. The spiral also limits the extent of the cracks in the concrete when they do occur, and confines the concrete even if it is cracked. No attempt is being made here to specify what percentage of spiral should be used, but it is evident that proper design in this respect is important. Forms and types of reinforcement used in the column tests are illustrated.

A NEW FORMULA NEEDED

From the evidence which has been presented as to the effects of shrinkage and flow, it should be obvious that the usual column formula, based on a ratio of stresses in the concrete and steel equal to n, is unreasonable. That such a division of stress does exist when the column is new has been amply demonstrated by others. That this situation does not exist afterward, under usual conditions of humidity and service, must be and is being generally recognized.

Evidently, under the influence of shrinkage and flow, n is no longer a factor, for, as the concrete flows, the n ratio is upset and, as it shrinks, the stresses of the two materials are not even necessarily of the same sign, since one may become tensile while the other remains compressive. That is why some of the specimens were cast with the bars greased, so that the two materials could act independently. It is interesting to observe that, in almost every case, these specimens took a slightly higher load than those with bars not greased, and were in somewhat better physical condition at the end of the test. It seemed as though the absence of bond between the materials afforded each a freedom of action which led to better ultimate results.

There is need for a design formula based on a theory more closely approximating actual conditions. Such a formula might well consider the effective strengths of the two materials treated separately. After all, the steel and the concrete are confined by the spiral. We have other examples, in engineering fields, of strength given to materials by confining them. Although the analogy is far from perfect, mention might be made of loads taken by sand when confined, or of the load water is capable of taking when held in a closed vessel. Adequate spirals in reinforced columns allow the effective strengths of the materials to be reached before failure occurs. In all spirally reinforced specimens in these experiments, the ultimate strength approximated the sum of the yield-point strengths of the steel and the ultimate strength of the corresponding specimens of plain concrete.

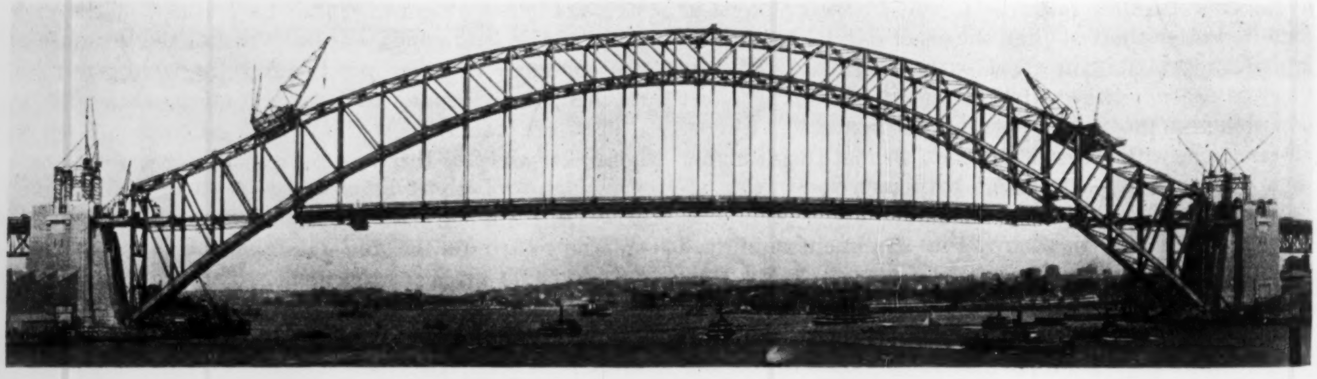
There is good reason for believing that, in the near future, structural engineers will be using a new type of formula. The evidence from these tests would indicate that such a formula is likely to be based on the yield-point strength of the steel and the ultimate strength of the concrete. Whether the percentage of spiral steel should be based on the percentage of longitudinal steel—arbitrarily assigned or left as an independent variable between limits—is a point that lies beyond the scope of these tests, but which will doubtless be settled in part, at least, by the comprehensive column investigation now being carried out by Committee 105. Some of our tests did show conclusively that added longitudinal steel places an added burden on the spiral, that is, it increases the tendency to buckle.

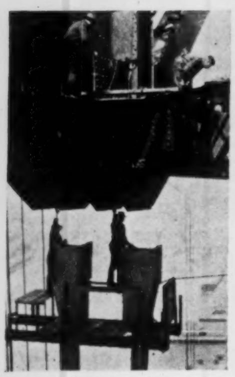
SOME VALUABLE RESULTS OBTAINED BY THESE TESTS

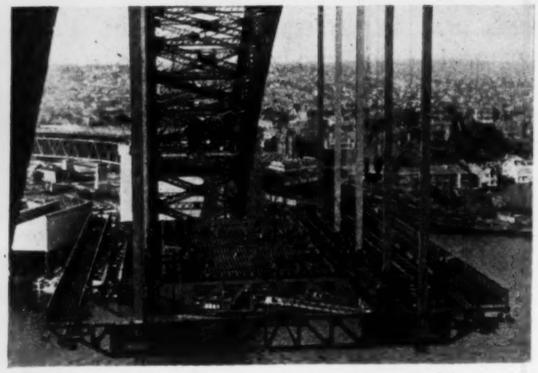
The important points brought out in the tests on the small columns with projecting bars were:

1. A tied column will split when, or soon after, the yield point of the longitudinal steel is reached.
2. In a properly spiraled column, yield-point stresses in longitudinal steel create no hazard.
3. Bond between steel and concrete is not essential in a spiraled column if the steel butts against unyielding ends.
4. In such a member as the reinforced-concrete spiraled column, n, the ratio of moduli of elasticity, is meaningless and may be discarded.

These tentative conclusions are in accord with those expressed in the recent progress report of Committee 105. By two widely different methods, yield-point stresses have thus been induced in the longitudinal reinforcement of spiral columns. It is most encouraging that in neither instance does there seem to be any indication that steel stresses of this intensity spell failure.







SYDNEY HARBOR BRIDGE

This Australian steel arch bridge is approaching completion. At the left are shown the heavy structural steel hangers supporting the massive roadway. The panorama indicates the progress of erection up to January 1931.

Photographs Furnished Courtesy of
Wm. G. GROVE, M. Am. Soc. C.E.
Robinson & Steinman, Consulting Engineers

A Century of Progress in Civil Engineering

Vital Factors in the Growth of the Nation

By Anson Marston, Past-President Am. Soc. C.E.
Dean of Engineering, Iowa State College, Ames
and Mark B. Morris, Assoc. M. Am. Soc. C.E.
Research Assistant, Iowa State Highway Commission, Ames

ALTHOUGH civil engineering achievements date back to the early days of American history, the science was often identified with other professions, such as that of surveying. In 1802 the first degrees in civil engineering were given in this country, to two cadets graduating from West Point. The construction of the Erie Canal and the Cumberland Road gave engineering training to a large body of men who were then able to contribute of their knowledge to the development of the rapidly growing country. This paper was originally prepared by Dean Marston and Mr. Morris as a radio address, and was broadcast from Station WEAF in New York by Harrison P. Eddy, M. Am. Soc. C.E., during the course of the Annual Meeting of the Society over a nation-wide hook-up.

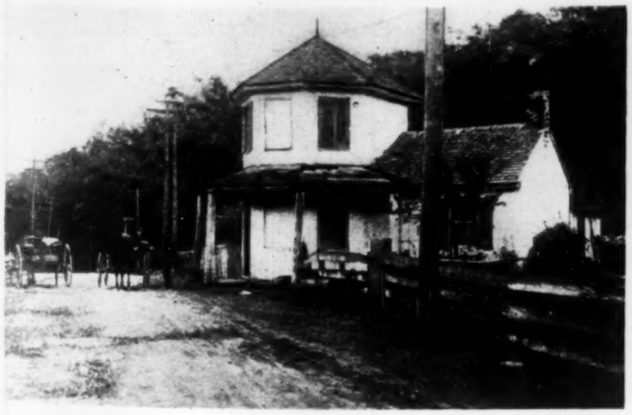
WITH the beginning of the nineteenth century came the great industrial revolution in Europe, which was characterized by the development and use of steam power, industrial machinery, and great highway, canal, and ocean transportation systems. This revolution inaugurated our modern industrial civilization, in which civil engineering is the most essential profession. So necessary to civilization has civil engineering been that many phases of it were practiced by educated men before it became definitely established as a profession.

In the United States, the history of the last century of progress in civil engineering is the history of the most important material achievements in the growth of the American nation. At the beginning of the century, early American surveyors preceded the pioneers in their advance westward across the continent. Then the problem of transportation across the barrier of the Allegheny Mountains and the broad valley of the Mississippi had to be solved by canal, highway, and railway engineers before our country could develop into a great nation. A brief glance at a few outstanding features of its development, from about 1800 to the present time, reveals a fascinating panorama.

With the dawn of the nineteenth century, the United States, a youthful nation just freed from parental authority by its successful struggle for independence, began to feel crowded in the territory occupied by the original Colonies. Settlement and development of new territories west of the Allegheny Mountains began at a rapid rate. Hardy pioneers pushed the frontiers westward through the mountains which so long had acted as a backyard fence for the thirteen original states.

Through natural gateways in this barrier, a thin stream of emigration trickled westward and spread over the broad, fertile lands in the valley of the Mississippi. Here new homes were established, and villages and towns dotted the plains. Vast stores of natural resources were everywhere in evidence—there were forests, navigable streams, vast stretches of fertile country, and rich mineral deposits. But it still remained for this youthful nation to properly develop and efficiently make use of these great gifts of nature.

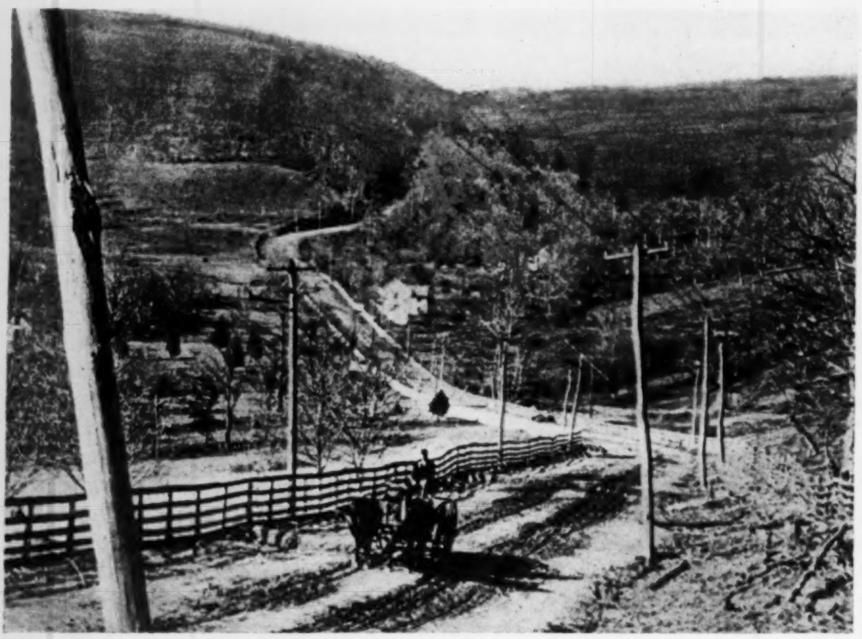
In this vast new empire none of our modern comforts and conveniences were available, although their crude forerunners were to be found in the original Colonies. Roads were little more than trails; so travel was difficult and costly in both time and money. There were no electric lights, no trains, no automobiles, no telephones, but little mail service, and few books or papers. Administration of territorial, state, and governmental affairs involved slow and cumbersome processes. In the great new inland territories, all food, clothing, and shelter were derived from purely local industry, except for a few such luxuries as paper, sugar, tea, coffee, and tobacco.



Old Toll House on the Cumberland Road
Near Frostburg, Md.

An Old Stage Coach That Formerly Plied the Cumberland Road

Privation and hardship due to a lack of the comforts of life and insufficient contact with the rest of the country, were a part of the daily lives of the early settlers. Yet they were surrounded by potential affluence just beyond their reach. They lacked facilities for transporting their products to market, for bringing goods to them, and for the free exchange of commodities and thought throughout the broad reaches of the new country.



Transportation Fifty Years Ago
Along the Cumberland Road

As a result of its rapid growth and expansion, the youthful republic was confronted with its first great engineering problem—that of providing economical, rapid, and efficient means of transportation within the country and from the interior to the eastern seacoast across the barrier of the Allegheny Mountains. Two great projects were proposed for the solution of the problem presented by the Allegheny Mountain barrier. One of these was the Cumberland Road, and the other the Erie Canal. In the surveying, planning, and building of these undertakings, civil engineering as a profession became definitely established in the United States and in America.

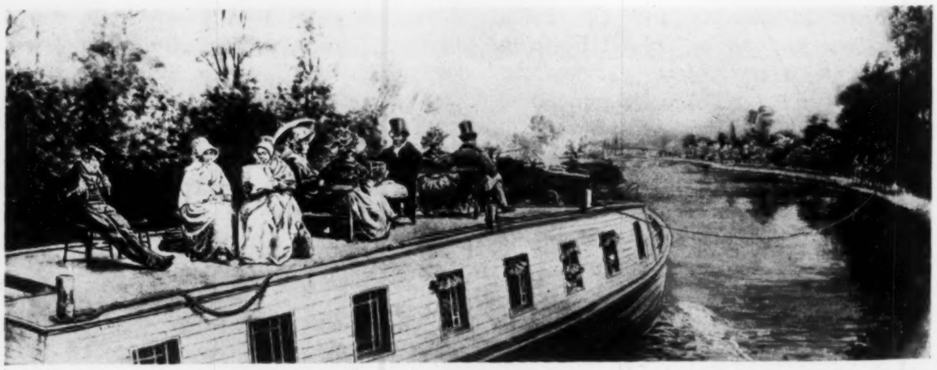
CUMBERLAND ROAD AND ERIE CANAL CONSTRUCTED

The Cumberland Road, extending from Cumberland on the Potomac, in Maryland, to Wheeling on the Ohio, in West Virginia, was started in 1811 and completed in 1818. Later it was continued to St. Louis, on the Mississippi. This extension was graded to Vandalia, Ill., but completely surfaced only to Springfield, Ohio. The Erie Canal, extending from Albany on the Hudson westward across New York State to Lake Erie, was started in 1818 and completed in 1825.

So new was the profession of civil engineering at the time these projects were undertaken that it was necessary to employ men of any technical education available. Only one technical school had been established, the U.S. Military Academy at West Point, where a class of two civil engineers was graduated in 1802. Even for the laying out of the city of Washington, D.C., the seat of the National Government, it had been necessary to engage L'Enfant, a French engineer.

The Cumberland Road was surveyed, planned, and built under the supervision of military engineers. Although the employment of an English engineer was at first considered necessary for the Erie Canal, American engineers were finally engaged for the work.

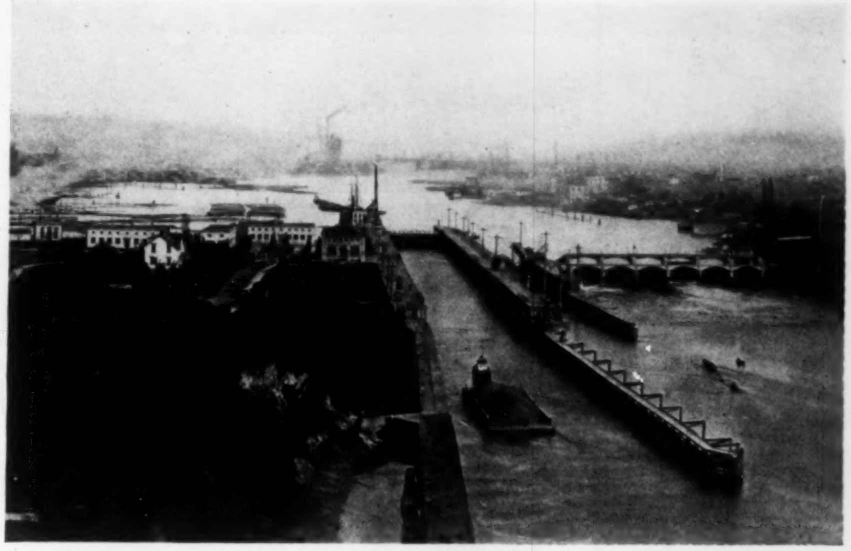
This great project has been frequently referred to as the first training school of civil engineering in America, for here a large body of men with and without previous technical training were schooled in the practice of civil engineering. Thus the Erie Canal and the Cumberland Road were in themselves engineering works of incalculable value in the industrial and social development of the United States, not only in the successful performance of the functions for which they were designed, but also in the training of a large group of civil engineers for the still more difficult task of keeping pace with the needs of the growing young nation.



One of the First Canal Boats on the Old Erie Canal
The Ultimate in Speed and Comfort About 1825

Through these two great arteries of traffic there immediately began to flow an unprecedented stream of commerce and migration. To civil engineering came almost immediately the task of improving the means of communication to care for the needs of the new era. The response was the development of the railroad, which soon outstripped its predecessors as a means of economical, rapid, and efficient transportation.

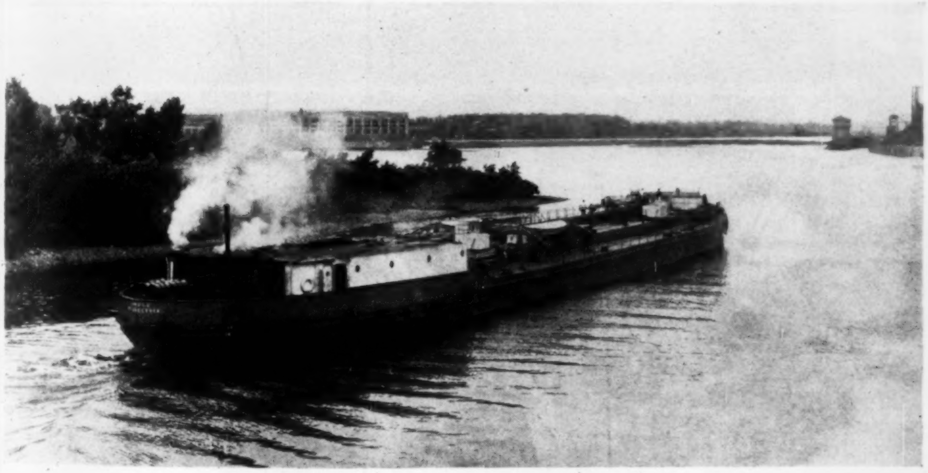
About this time science contributed to the world a wider knowledge of the characteristics of materials, developed a method for the cheap and large-scale production of steel, perfected a hydraulic cement, and offered more exact methods for the mathematical analysis of stresses in structures. Armed with these new tools and materials, civil engineering began, between 1850 and 1860, the rapid progress in its development which has been accelerated, decade by decade, to keep pace with the new and more complex needs of the country.



LOCKS, DAM, AND GROUNDS OF THE LAKE WASHINGTON SHIP CANAL
Intermediate Lower Gates of Large Lock Open

Steel permitted improvement and greater expansion of the railroads by providing a cheap, efficient, and dependable material for rails, bridges, buildings, tools, and machines. The availability of a material such as steel, which had dependable strength characteristics, permitted the mathematical computation of stresses in the members of a bridge, building, or ship, and in erection equipment and cargo-handling machinery, and thus enabled civil engineering to make rapid progress in the perfection of designs for such structures. The cheapness of steel, made possible by large-scale production, was largely responsible for the diversity of the uses to which it was put.

DEVELOPMENT AND GROWTH OF CITIES



GASOLINE MOTOR SHIP ON THE ERIE CANAL
Near Waterford

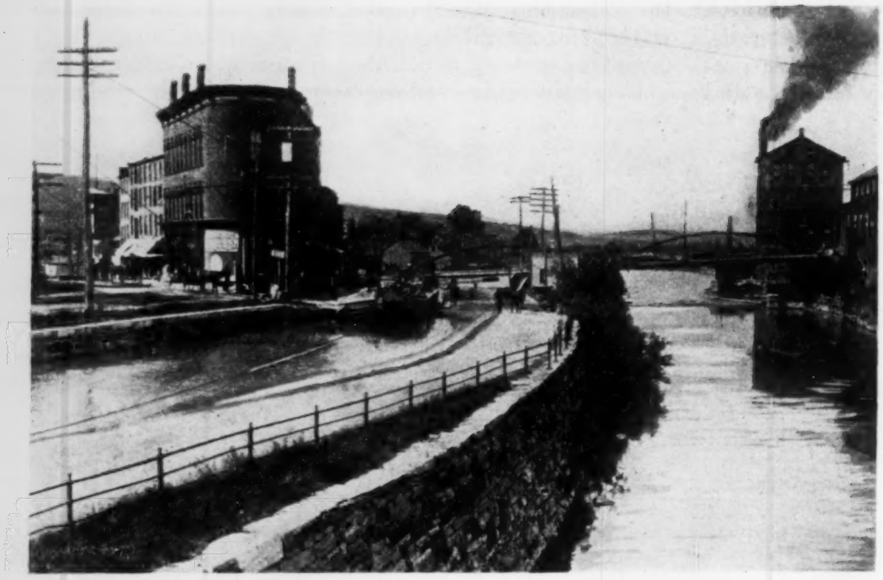
Efficient and rapid means of transportation concentrated industrial activity in certain strategic areas; the impetus of commerce and industry brought masses of people together in the centers of manufacturing and trade; and the concentration of people and goods added to the responsibilities and activities of civil engineers. Safe and dependable water supplies and sewerage systems became necessary to protect health in the cities and towns. The transportation of masses of people to and from work, the efficient housing of employees in great office buildings and factories, and the expansion of terminal facilities for both land and water transportation systems, presented increasingly complex problems, which the engineer was asked to solve.

Ever expanding, civil engineering has met the challenge of each new problem with successful achievement. Seeking always for more efficient means of moving people and goods by land or water, for better methods of protecting and purifying public water supplies, for a more economic utilization of natural resources, and for a more efficient use of materials, civil engineering has made a great effort to facilitate the attainment of greater comforts and conveniences.

As a result of this effort, modern civilization is surrounded by numerous comforts, conveniences, and luxuries which are beyond even the dreams of a century ago.

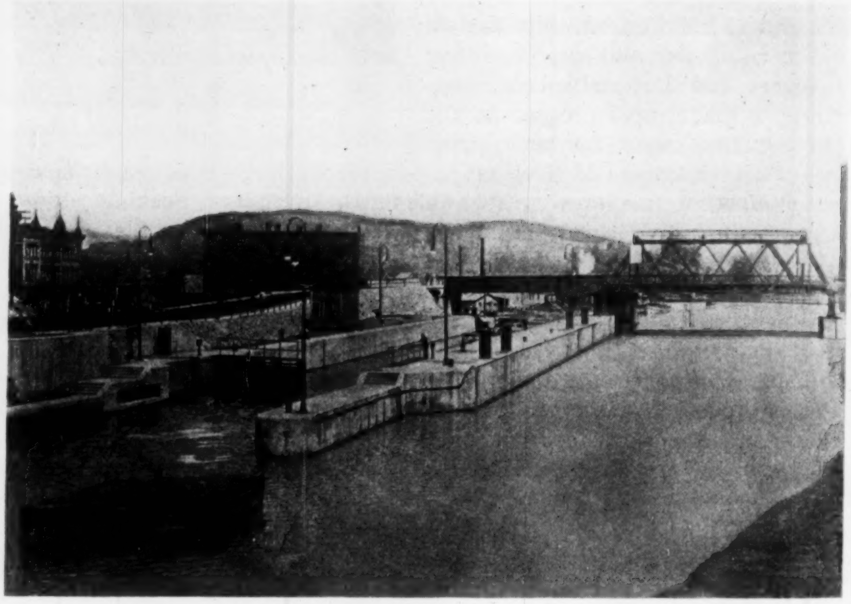
MECHANICAL INVENTION ALSO PLAYS ITS PART

Occasionally a new comfort or convenience has inspired a whole new group of civil engineering achievements. For example, mechanical engineering genius developed the automobile to a high state of perfection and created a marvelous factory method for its production in large quantities at a low price. As a result, millions of cars were soon in the possession of private owners, whose desire was to be able to go anywhere at any time. In a body, therefore, they demanded highways for the utilization of their cars. Now an annual expenditure of $1,600,000,000 is required for roads, and this enormous sum only partly satisfies the traffic needs of the 26,000,000 automobile owners. The building of highways has required great engineering



OLD CHAMPLAIN CANAL AT WHITEHALL
As It Appeared from 1840 to 1910

organizations and whole new industries for the manufacture of materials and machinery.



NEW BARGE CANAL AT WHITEHALL
Lock 12, Completed in 1911

This is but one example of the progress in civil engineering which followed the construction of the Cumberland Road and the Erie Canal, and led to the great achievements which may be seen all around us today—in towering skyscrapers, magnificent bridges, monumental power dams, great irrigation and reclamation works, in the marvelously coordinated harbor and dock facilities of a modern lake or ocean port, in greater water supply and sewerage systems, and in the all-embracing network of railways and highways.

At a great exposition to be held in Chicago during 1933, a dramatic presentation of a century of progress in all the sciences will be effected by means of striking exhibits of the scientific discoveries and achievements of the century just passed. Among these exhibits will be presented the developments in civil engineering from the early part of the last century to the time of the exposition.

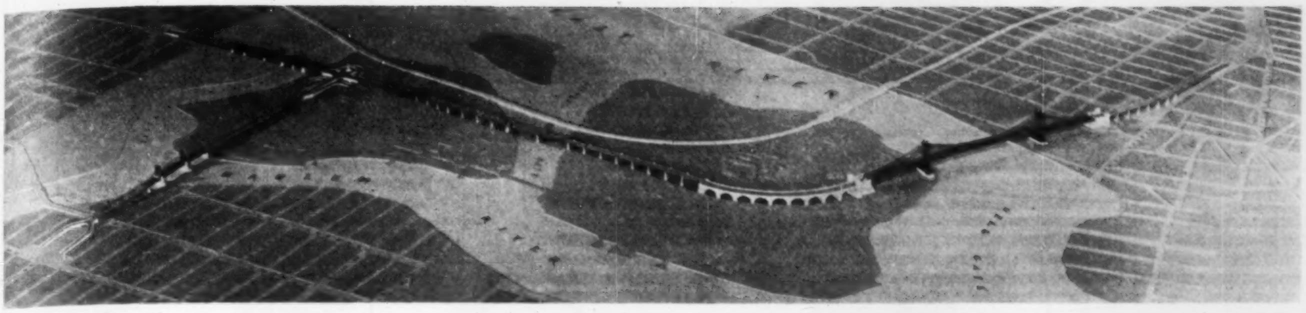
U.S. Bureau of Public Roads

OLD BRICK TAVERN ON CUMBERLAND NATIONAL ROAD
Clarysville, Maryland

The achievements of today can only be mentioned, for the modern mind leaps forward into the tomorrow, foreseeing needs, comforts, and luxuries, and devising means of satisfying them. The visions of what may be, dwarf and dim the picture of the present. In a hundred years our descendants may look back upon our great achievements in civil engineering and other fields as being even less monumental than we consider those of the century just passed.

This much can be said without going too far into the field of prophecy, for projects are even now being planned on such a scale and of such far-reaching consequences as have never before been considered. At least one of these projects, the construction of Hoover Dam in Boulder Canyon, has just been started.

The continents of North and South American will be linked with railways and highways, and the vast agricultural lands of the southern continent will be served with an adequate transportation system and developed to the full extent of their potentially great resources. Likewise, the inaccessible regions of Asia will be made available for the efficient service of man, and the great untouched stores of natural resources in India, China, Russia, and Africa will be developed. The mighty rivers of the world will be harnessed to furnish power and transportation, or to prevent damage by floods. Such a project for the Mississippi, the Ohio, and the Missouri rivers is being rapidly carried out. Skyscrapers will reach even farther toward the sky, and the bridges of today will be in the shadow of greater structures.



Increasing the Vehicular Capacity of Manhattan's Bridges

By EDWARD A. BYRNE

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, DEPARTMENT OF PLANT AND STRUCTURES, NEW YORK, N.Y.

THE heart of New York is an island, and the city is faced with the increasingly serious problem of providing adequate river crossings to connect Manhattan with the surrounding territory. Vehicular traffic demanding accommodation on the existing bridges is growing faster than provisions can be made for it. Statistics of gasoline consumption indicate that travel has increased even more rapidly than has car registration. When opened to traffic nearly fifty years ago, Brooklyn Bridge took the place of five ferries, and its designers felt that it had sufficient capacity to meet the traffic needs of several generations. Now four East River bridges are overcrowded and special measures have been employed to provide them with extra capacity. In this article, originally presented before the Metropolitan Section of the Society, Mr. Byrne describes the provisions that are being made to handle, with the facilities available, the flood of traffic clamoring for daily access to Manhattan Island.

SOME measure of the great increase in the number of people able to afford the luxury of motor cars for private use is afforded by the statistics of vehicular traffic on the four bridges which span the East River between Manhattan Island and sections of New York to the east. The number of privately owned automobiles passing over these bridges—the Brooklyn Bridge, the Williamsburg Bridge, the Manhattan Bridge, and the Queensboro Bridge—has shown an increase beyond any estimates that the officials of the Department of Plant and Structures could ever possibly have made.

Statistics indicate that this increase has been particularly apparent during the past ten years. In 1919, private passenger cars constituted 50.2 per cent of all vehicular traffic on the East River bridges. In 1924, the percentage had increased to 67.6 per cent, and in 1929 it had reached 78.9 per cent. In terms of actual counts, the number of passenger cars was six times greater in 1929 than in 1919, or 184,941 as compared to 31,495. In the same period, the number of vehicles other than passenger cars had increased only about 1.6 times, or from 31,245 in 1919 to 49,459 in 1929. The question naturally arises, how far can we go in the matter of providing facilities for the future if this increase is to continue at the same rate that it has in the past ten years? The growth of traffic over the East River bridges is shown graphically in Fig. 1.

In 1919, there were available 143 traffic lanes for vehicles on the various bridges under the jurisdiction of the Department of Plant and Structures; at the close of 1931, there will be available 204 for vehicular traffic. Projects, authorized for the next five years, when completed, will provide a total of 246 lanes for vehicular traffic, an increase of 103 lanes over the number available in 1919.

In addition, partial appropriations have been made for the construction of the 38th Street Tunnel under the East River and the Brooklyn-Staten Island Tunnel. To provide the additional facilities necessary over the Harlem Ship Canal, four different projects have been prepared for the consideration of the city authorities. The building of the Hudson River Bridge (the George Washington Memorial Bridge, at Fort Lee) makes a new bridge necessary across the Harlem River at West 178th Street, to take care of the Bronx traffic.

Of the 49 bridges in service at the present time, the four East River bridges carry about one-third of the total vehicular traffic. The East River bridges have a combined total of 40 lanes, of which 22 designed were for railroad tracks and 18 for vehicles. In 1922, two railroad lanes were reconstructed for vehicular traffic, and in 1931 five additional lanes are being provided, two on Manhattan Bridge and three on the Queensboro Bridge. Figure 2 shows existing and proposed structures.

The East River bridges were designed primarily for railroad traffic, but due to the decrease in passenger traffic carried by the trolley companies, the spaces occupied by trolley tracks on the Manhattan Bridge have been reconstructed for vehicular purposes. Trolley lines on the Williamsburg, Queensboro, and Brooklyn bridges should be discontinued, and busses used in their places, so that the space now occupied by them could be used for vehicular traffic. By this means, four additional lanes could be added on the Williamsburg Bridge, and two on the Queensboro Bridge.

Since these bridges were designed, the feasibility of operating rapid transit trains in tunnels has been

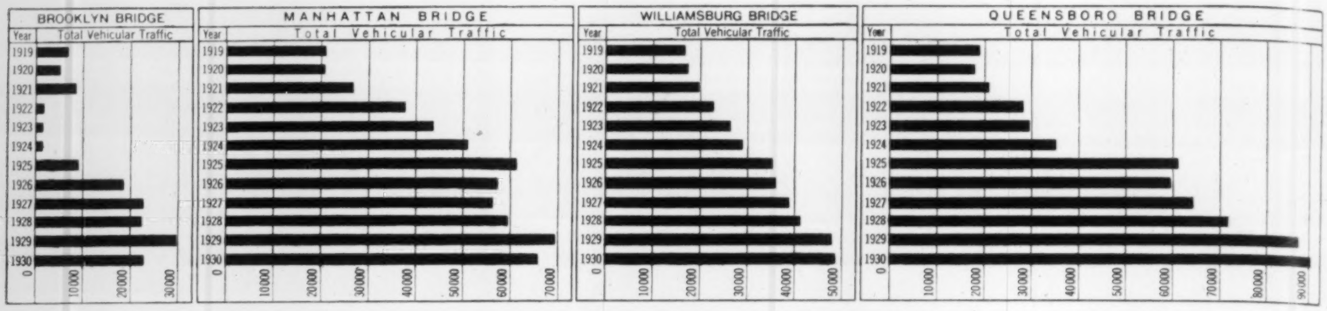


FIG. 1. VEHICULAR TRAFFIC COUNT FOR 24 HOURS
East River Bridges, New York

demonstrated from the standpoint of maintenance and speed. Thus the suggestion that such trains be taken from the bridges and placed in tunnels is most reasonable and is so recognized by all concerned. The cost of changing from bridge to tunnel is the only obstacle.

TABLE I. ANNUAL TRAFFIC COUNT FOR 24-HOUR PERIOD, OCTOBER 1929

Bridge	Total Cars: Rapid Transit	Total Cars: Surface	Total Passengers	Total Vehicles
Queensboro .	1,874	1,009	101,756	87,385
Williamsburg	3,814	1,838	316,643	47,992
Manhattan .	5,621	568	489,046	69,301
Brooklyn . .	5,552	3,142	129,697	29,992
Total for 1929	16,861	6,557	1,037,142	234,670
Total for 1919	13,797	16,447	936,065	62,740

On October 24, 1929, a total of 29,992 vehicles and 3,142 trolley cars crossed Brooklyn Bridge in a period of 24 hours.

On the same day, 28,656 vehicles used the Holland Tunnel. In the year 1929, a total of 10,977,910 vehicles passed through the Holland Tunnel. Using the same day-to-year ratio for the bridge as for the tunnel, it will be found that Brooklyn Bridge carried 500,000 more vehicles in 1929 than the Holland Tunnel, exclusive of 1,300,000 trolley cars, which crossed on the same roadways as the vehicles.

The greatest congestion for a one-hour period at the Queensboro Bridge was recorded in 1929, when 6,576 vehicles crossed over—4,445 eastbound, and 2,133 westbound. This showed an increase of 41.8 per cent over a similar period in 1924, when a total of 4,639 vehicles passed over.

The records in Table I, from counts made by the Department of Plant and Structures for the four East River bridges, over a period of 24 hours in 1929, show the amount of various kinds of traffic on these bridges and indicate that the Queensboro Bridge carried only 10 per cent of the railway passenger traffic on the four East River bridges, although it accommodated 37 per cent of the vehicular traffic.

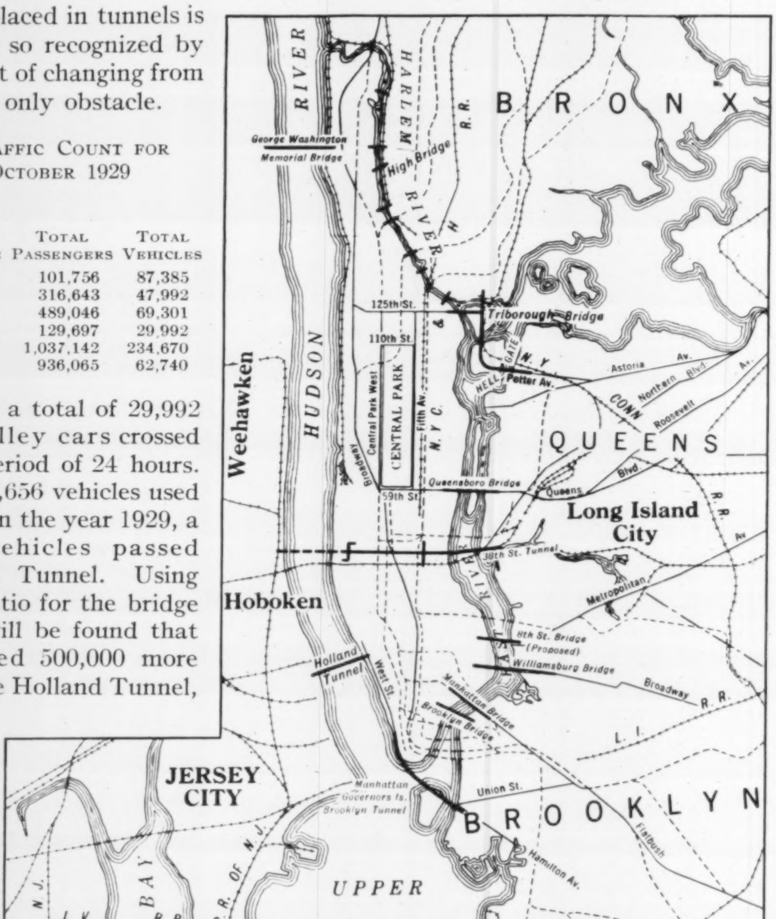

HUDSON RIVER
HARLEM RIVER
B R O N X
George Washington Memorial Bridge
High Bridge
125th St.
110th St.
Triborough Bridge
HELL GATE
N. Y. CONN R. R.
Potter Av.
Astoria Av.
Northern Blvd.
Roosevelt Av.
Weehawken
Broadway
Central Park West
5th Av.
CENTRAL PARK
N. Y. C.
Queensboro Bridge
59th St.
Queens Blvd
Q U E E N S
Long Island City
38th St. Tunnel
Metropolitan
Hoboken
11th St. Bridge (Proposed)
Williamsburg Bridge
Holland Tunnel
West St.
Manhattan Bridge
Brooklyn Bridge
Broadway
L. I. R. R.
EAST RIVER
JERSEY CITY
Manhattan Governors Is. Brooklyn Tunnel
Union St.
B R O O K L Y N
Flatbush
Hamilton Av.
L. V. R. R.
C. R. R. OF N. J.
NEWARK BAY
UPPER NEW YORK BAY
Bayonne
MAN. BEACH R. R.
New York Bay Tunnel (Proposed)
Narrows Tunnel (Proposed)
Kill Van Kull Bridge
CONEY ISLAND
Goethals Bridge
RICHMOND
STATEN ISLAND
0 1 2 3 4
Scale in Miles

FIG. 2. VEHICULAR BRIDGES AND TUNNELS OF NEW YORK

QUEENSBORO BRIDGE DECKS RECONSTRUCTED

This congestion on Queensboro Bridge became aggravated even from day to day and plans for relief were submitted by various interests, but for one reason or another they were discarded. In November 1926, the Department of Plant and Structures presented a plan for relief which provided for an additional roadway on the upper deck of the bridge, with two outlets in Queens and Manhattan, one from the upper deck and one from the existing lower deck. With slight modification, the plan of the department was approved and funds were made available for construction.

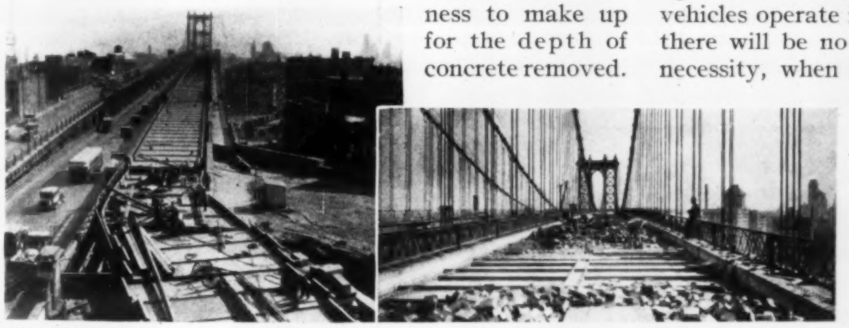
The outlet from the lower deck to East 62nd Street was temporarily eliminated from the plan. Work on the installation of the new upper deck roadway advanced rapidly, and it was opened to traffic on June 25, 1931.

Specifications for the Queensboro Bridge, which was designed by the engineers of the Department of Plant and Structures over 25 years ago, called for the following capacities: a "regular" live load of 8,000 lb. per lin. ft. of bridge, and a congested live load of 16,000 lb. per lin. ft. for the main members of the trusses and towers. As constructed and opened to traffic in 1909, the bridge had accommodations for only two tracks for an elevated railway, and four for trolley cars.

In 1916, in order to provide additional roadway facilities, the two trolley railway tracks were removed from the roadway, at which time the entire pavement of the roadway was reconstructed. This plan provided for a decrease in the weight of the roadway amounting to 783 lb. per lin. ft. of bridge.

Manhattan Approach Plaza

During the past four years, the heavy motor truck traffic has caused the steel buckle-plate floor to fail, and the department is now reconstructing it with stronger steel plates, reinforced with heavy angles. This work includes the elimination of the concrete foundation on which the wood blocks rested, the wooden blocks being increased in thickness to make up for the depth of concrete removed. In this design, which is similar to that adopted for the roadways of the Manhattan Bridge, the wooden blocks rest directly on the steel floor, reducing dead load 417 lb. per lin. ft. of bridge.



Approach Construction   Laying Wood Blocks on the Suspension Span

New Upper Roadway of the Manhattan Bridge Opened for Traffic June 1931

The plan for the additional roadway on the upper deck provides for the removal of the two elevated railway tracks from the center to the northern half of the bridge and the entire removal of the two concrete footwalks and the heavy metal railings. The weight of the material removed is 1,470 lb. per lin. ft. of bridge, while the weight of the new roadway and footwalk is 1,200 lb. per lin. ft., a reduction in dead load of 270 lb. per lin. ft. These changes will mean a reduction in dead load of 1,470 lb. per lin. ft. of bridge, making a total of 5,475,000 lb. (2,737 tons) that have been removed from the bridge since 1916. It is expected that this new roadway will accommodate from 45,000 to 50,000 cars in a 24-hour period if necessary.

This new roadway on the Queensboro Bridge has some points that are of interest. It is located on the southern part of the upper deck, and has a terminal in Manhattan at East 57th Street, 200 ft. east of Second Avenue, and two terminals in Queens. It is 10,313 ft. in length and without any grade crossings. The terminals in Queens are about one-half mile distant from the present main bridge terminal, and 750 ft. from the Manhattan terminal at 59th Street and Second Avenue.

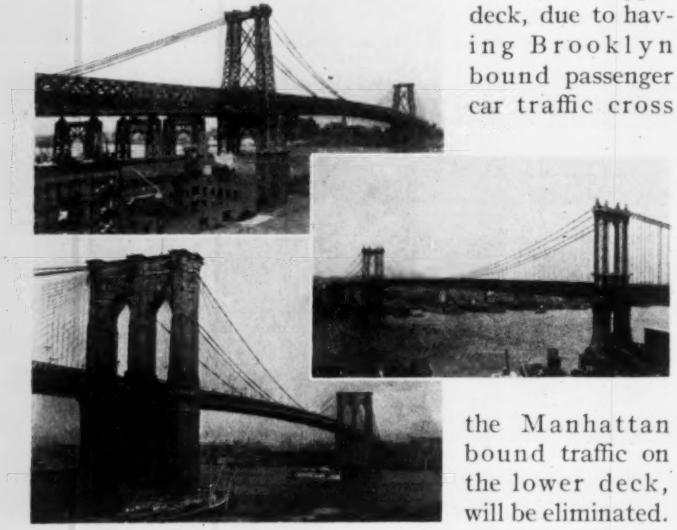
Brooklyn Approach Plaza

A unique feature is that which provides for three lanes of traffic in a width of 22 ft. 6 in., for a distance of 3,730 ft. on the main span of the bridge. This roadway is for light automobile traffic and is so designed that the vehicles operate in grooved paths, 2 in. in depth. Thus there will be no weaving out of line except in case of necessity, when it is quite easy for cars to pass from groove to groove by moving over the 2-in. curb. The grooved floor is of steel, and was fabricated and shipped in units 10 ft. 6 in. long and the full width of the roadway, including the outer curbs. These plate sections were delivered and approximately located at night, and then put in their final positions during the day, with practically no interference to vehicular traffic. The cost of the construction will be about $1,800,000, and the estimated cost of the property to be acquired is about $3,000,000.

INCREASING THE CAPACITY OF MANHATTAN BRIDGE

At the Manhattan Bridge there are six vehicular traffic lanes, four on the lower deck and two on the northern half of the upper deck. To meet the demand for additional facilities, which is urgent, we have been able to purchase the rights of a surface railway company which operated cars on the southern half of the upper deck and to use this space for vehicular purposes. The new roadway will be generally 22 ft. 6 in. in width and will be used for passenger automobiles bound for Brooklyn. The existing roadway on the northern side of the upper deck will then be used exclusively for light traffic bound for Manhattan. The main roadway on the lower deck will be used for trucks and busses.

The terminals are located at the ends of the present bridge, but the crossing of the traffic on the present lower deck and on the northern upper deck, due to having Brooklyn bound passenger car traffic cross the Manhattan bound traffic on the lower deck, will be eliminated.



EAST RIVER SUSPENSION BRIDGES
Williamsburg Bridge Manhattan Bridge
Brooklyn Bridge

In general, the design of the floor is similar to that of the new roadway on Queensboro Bridge. It was not practical, however, to install groove construction as the width of the roadway at the anchorages is only 19 ft. 6 in. The cost of this reconstruction was about $600,000, and that of the railroad company's franchise was $207,000. Traffic began using the new roadways on June 18, 1931.

With the completion of the new roadways on the Manhattan and Queensboro bridges there cannot be any further increase in vehicular traffic facilities on these bridges, unless the surface cars now operating on them are removed.

Traffic by ferry across the Hudson River is about 10 per cent greater than that through the Hudson Tunnel, but ferry traffic across the East River is only about 1 per cent of the bridge traffic. It is estimated that the total volume of traffic across the East River is nearly four times greater than that across the Hudson, as may be seen in Table II.

NEW TUBE PROPOSED

The need for additional vehicular connections between Brooklyn and the lower section of Manhattan is generally admitted, but it is apparent that any such connections must be planned so that congestion in the streets will be decreased rather than increased. The plan should remove traffic from congested areas and as far as possible should avoid its crossing main arterial highways at grade. Its location is shown in Fig. 3.

TABLE II. TOTAL VEHICULAR TRAFFIC IN 1929

HUDSON RIVER		EAST RIVER	
Ferries	11,852,000	Ferries	850,000
Holland Tunnel	10,998,000	Brooklyn Bridge	11,500,000*
		Manhattan Bridge	26,500,000*
Total	22,850,000	Williamsburg Bridge	18,500,000*
		Queensboro Bridge	29,000,000*
		Total	86,350,000

* Estimated.

I submitted a plan for a vehicular tunnel in January 1929, to provide for the relief of traffic in the lower section of Manhattan and in the central section of Brooklyn. This artery will tend to reduce the number of vehicles on the three southerly East River bridges, and at the same time eliminate to a great extent the congestion on the crosstown streets in Manhattan below 23d Street, by having a great part of the present East River bridge traffic diverted to the north and south streets in the Borough of Manhattan.

Hamilton Avenue, Brooklyn, has been selected as the terminus of the proposed tube from lower Manhattan because it is in the heart of the Brooklyn industrial center. The area to the north, Brooklyn Heights, is of much greater elevation and is therefore less desirable as a location for a tunnel terminal. The proposed tunnel consists of two tubes, each 32 ft. in diameter, accommodating three separate lanes of traffic, a unique feature in vehicular tunnel design. As designed, the total length of single tube is 24,285 ft., and the roadway at its lowest point is 98 ft. below mean sea level. The Holland Tunnel has a total single tube length of 18,588 ft.

In Manhattan, the entrance to, and exit from, the tunnel are located in West Street, at Rector and Cedar streets, respectively. This location gives access to the entire western waterfront of Manhattan, with its piers and railroad terminals. By means of ferries and the Holland Tunnel, the area west of the Hudson River is

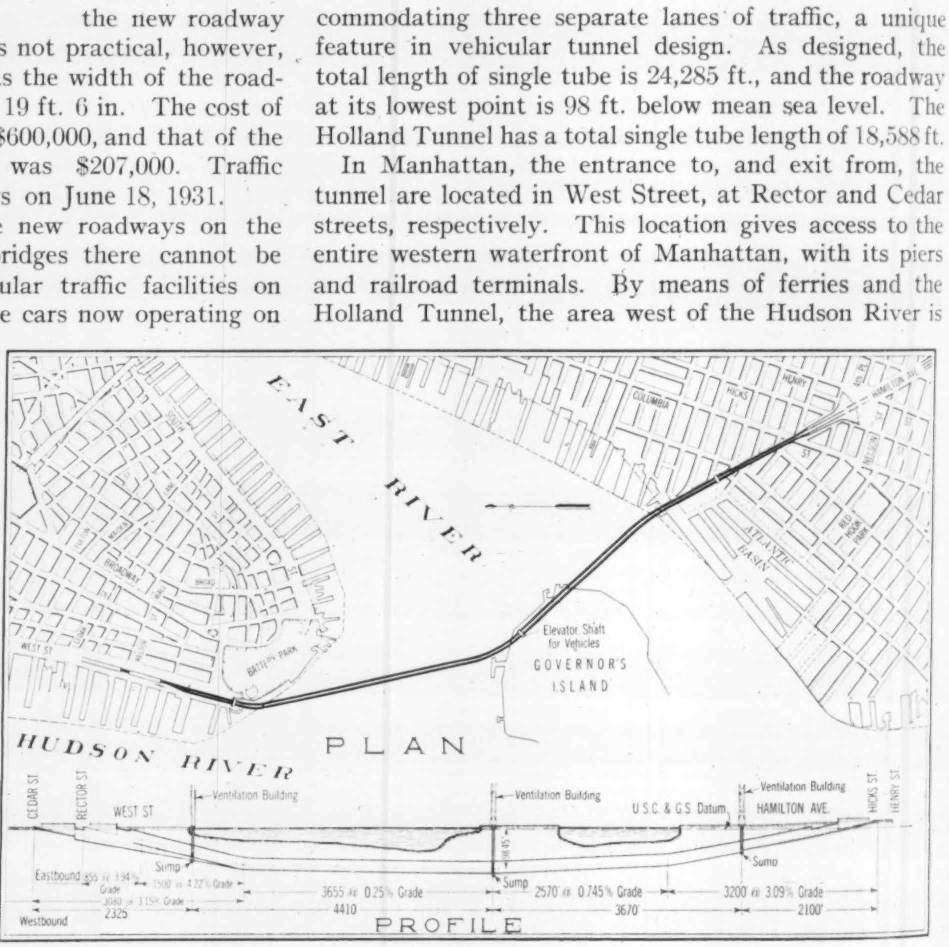
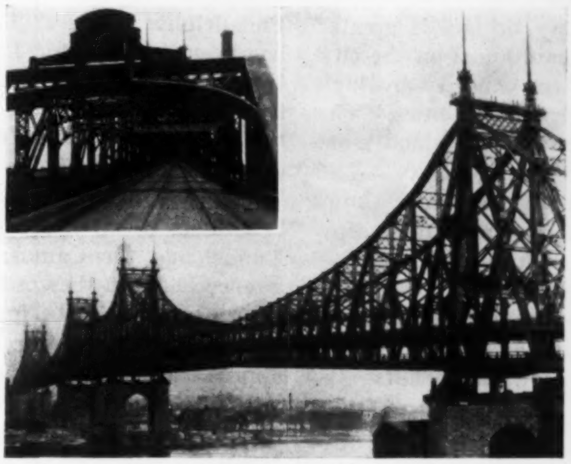

EAST RIVER
Elevator Shaft for Vehicles
GOVERNOR'S ISLAND
BATTERY PARK
WEST ST
BROADWAY
COLUMBIA
HICKS
HENRY
HAMILTON AV
ATLANTIC BASIN
HUDSON RIVER
PLAN
CEDAR ST.
RECTOR ST.
WEST ST
Ventilation Building
Ventilation Building
Ventilation Building
U.S.C. & G.S. Datum
HAMILTON AVE.
HICKS ST.
HENRY ST.
Sump
Sump
Sumo
98.45'
Eastbound 855' @ 3.94% Grade
1500' @ 4.22% Grade
3080' @ 3.15% Grade
3655' @ 0.25% Grade
2570' @ 0.745% Grade
3200' @ 3.09% Grade
Westbound
2325
4410
3670'
2100'
PROFILE

FIG. 3. PROPOSED TWIN-TUBE VEHICULAR TUNNEL
Manhattan to Governor's Island to Brooklyn

also easily accessible. This result is accomplished without crossing any of the north and south thoroughfares in Manhattan. Traffic can readily reach the west-side express highway by proceeding northward on West Street. The main north and south arterial highways, West Street, Varick Street-Seventh Avenue, and Church Street-Sixth Avenue, are all readily accessible.

In Brooklyn, the entrance and exit on Hamilton Avenue permit the transportation of freight by the shortest possible route from factories and piers, in the entire area from the Navy Yard to Bay Ridge, directly to the west side of Manhattan. At the same time, that much traffic is removed from the congested area of Brooklyn, the East River bridges, and the cross streets of Manhattan.

The estimated cost of construction for two two-lane tunnels is $50,000,000, and the assessed valuation of the property to be acquired is $1,500,000. The estimated cost of construction of two three-lane tunnels, shown in Fig. 4, is $58,000,000, or an increase of 50 per cent in capacity at an increase in cost of only 16 per cent.


Reconstruction of Upper Deck, Queensboro Bridge
In Insert, Groove Construction for Passenger Automobiles; Grooves Paved with Wood Blocks; Bridge Opened June 1931

Queens Approach

One of the great projects for the relief of vehicular congestion, the Triborough Bridge, is now in course of construction. This bridge was suggested by the writer, who prepared a plan for it in 1916. It connects the boroughs of Manhattan, the Bronx, and Queens, and is so planned that its terminals will be located at points where vehicular traffic can be readily distributed. Traffic between the Long Island boroughs and the Bronx and upper Manhattan will thus be kept out of the congested areas of lower Manhattan.

Approach spans in the boroughs of Manhattan, the Bronx, and Queens, and on Ward's Island and Randall's Island consist of granite faced masonry arches and viaducts, and of steel arches and viaducts. The steepest grade of the entire structure will be a 3.78-ft. rise per 100 ft., for a distance of 237 ft. Over the entire length of the bridge the average grade will be less than 2 ft. of rise per 100 ft.

Eight lanes of vehicular traffic are provided on the Main Bridge and six lanes on the Manhattan Connection. By means of a masonry structure consisting of ramps and loops, built at the intersection of the Manhattan Connection and the Main Bridge, uninterrupted traffic will be maintained to and from all three boroughs in all directions. This structure will also permit access to and from Randall's Island.

Ample footwalks will be provided over the entire structure, but no railroad facilities. The need for additional vehicular facilities has been anticipated in the design of the structure, which is capable of carrying an upper deck to provide eight additional lanes of traffic on the main bridge.

Dimensions of the Triborough Bridge are as follows:

Span	Vertical Clearance in Ft.	Length in Ft.
Main Bridge from the Bronx to Queens		13,560
Hell Gate crossing (suspension span, 1,380 ft. long)	135	
Little Hell Gate crossing (2 steel arch spans, each 375 ft. long)	50	
Bronx Kill crossing (2 spans, each 125 ft. long)	50	
Manhattan Connection, from the Main Bridge to East 125th Street		4,150
Harlem River crossing (320 ft. long, single span, vertical lift):		
When open to vehicular traffic	55	
When fully raised for navigation	135	
Total length of bridge		17,710

The estimated cost of the bridge is $32,000,000, and appropriations to an amount of $8,000,000 are now available. Contracts to the amount of $2,465,000 have been awarded. These contracts call for the foundations of 19 piers and the anchorage for the suspension span on Ward's Island, and the tower pier and anchorage in the Borough of Queens. About 40 per cent of the total amount contracted for has been completed. Property for the approaches is being purchased by private sale and by condemnation, and it is expected that the structure will be completed in about four years.

Those opposed to this con-

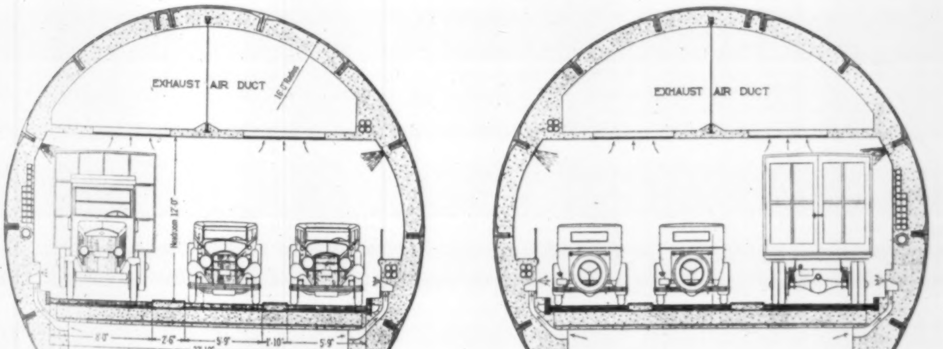


Fig. 4. Cross Sections of Twin 32-Ft. Tubes
Two Lanes for High Speed, One for Trucks

struction claim that tunnels should be built in place of the bridge. They contend that tunnels are superior to bridges because they provide greater capacity, with less congestion at terminals, owing to (1) greater speed of vehicles, (2) less interference from repairs to roadways, and (3) freedom from hampering weather conditions, such as fog, rain, snow, and ice.

My answers to these points follow:

1. Speed of vehicles on the city bridges is greater than the rate that can be safely maintained on the city streets. There is nothing gained in capacity by high speed in a tunnel or on a bridge in populous cities. The higher the speed, the greater the distance which must be maintained between vehicles to ensure safety. The plazas of the Holland Tunnel have been made large enough to "bunch" vehicles held up by cross traffic after passing through the tunnel at a high rate of speed.

Some tests that should be of interest have been made by the automotive interests to determine the space required to stop automobiles traveling at various rates of speed. The following tabulation shows the results:

SPEED OF CAR	DISTANCE REQUIRED TO STOP
20 miles per hour	24 ft.
30 miles per hour	55 ft.
40 miles per hour	98 ft.
50 miles per hour	154 ft.

Other tests show that it takes from 0.5 to 1.5 sec. for the normal human being to take his right foot off the accelerator and depress the brake after he sees or hears anything that should cause a quick stop. Applying this to actual practice, and considering the time required for reaction as 1 sec., then a car traveling 30 miles per hour, or 44 ft. per sec., will cover 99 ft. before it can be brought to a full stop.

2. No doubt those who claim that fewer repairs to the roadway are required in a tunnel than on a bridge have the Queensboro Bridge in mind, but lack a full knowledge of the reasons for the conditions complained of there. All the steel buckle plates which support the pavement of this bridge have been broken by the great number of heavy vehicles using the structure, and have had to be replaced. This is because such heavy traffic was not expected when the bridge floor was designed over 25 years ago. However, it will be necessary at various periods to repair any pavement, whether it is on a bridge or in a tunnel.

3. It is contended that weather conditions such as fog, rain, snow, and ice hamper the movement of bridge traffic. When the Holland Tunnel project was being promoted, delay to ferry traffic from this cause was emphasized. At that time there had been more or less interference with the movement of the Hudson River ferries, from fog, ice, and labor troubles.

There has been no interruption to traffic on the East River bridges, due to fog. As to rain and snow, the city streets are affected by them as much as the roadways of bridges and the terminals of tunnels. There is less traffic moving when there is snow, whether on the streets or on the bridges, but that cannot be advanced as a valid reason for building a tunnel instead of a bridge.

Another factor to be considered when choosing between bridge and tunnel construction is that of cost. The four-lane Holland Tunnel, which is 9,228 ft. in length, cost $48,000,000, or $12,000,000 per lane. The ten-lane Camden-Philadelphia Bridge, which is 9,570 ft. in length, cost $36,000,000, or $3,600,000 per lane. These costs do not include interest on bonds issued.

The George Washington Memorial Bridge over the Hudson River is not as yet completed. Bonds to an amount of $60,000,000 have been issued and the interest on them for a period of five years would have to be deducted from the final cost to compare its cost with those of the Holland Tunnel and the Camden-Philadelphia Bridge. The main span of this bridge has been designed for 12 lanes of traffic. A conservative figure of $5,000,000 per traffic lane might be used for comparing the cost of traffic lanes on this bridge with those of the Holland Tunnel. This means that the crossing of rivers of equal span by tunnel will cost at least two and one-half times more than by bridge.

As demonstrated by official reports for the Holland Tunnel and the Camden-Philadelphia Bridge, the difference between the costs of maintenance and operation for a tunnel and a bridge is much greater than that between their first costs. These two structures are of approximately the same length, and in 1929 they carried nearly the same number of vehicles. In that year the traffic which passed through the Holland Tunnel amounted to 10,977,910 vehicles, and that over the Camden-Philadelphia Bridge, to 11,615,609 vehicles. The maintenance expenses for the Holland Tunnel were $1,483,228; and for the Camden-Philadelphia Bridge, $388,522. The cost per traffic lane for the tunnel was thus $370,800, and for the bridge (six lanes in service), $64,700.

When the ten lanes are open to traffic, the annual cost of operation and maintenance will be about $550,000 per year, or $55,000 per lane, as compared with the tunnel cost of $370,800 per lane. This means that the annual maintenance and operation charges for the bridge will be about 15 per cent of the corresponding tunnel charges per traffic lane. It is far from my thought to imply that bridges should be built instead of tunnels at every location where possible. Other considerations may make a tunnel preferable to a bridge.

If a tunnel is constructed, it should be provided with three lanes for traffic in each direction, two for fast-moving, and one for slow-moving vehicles. Bridges across the East River should be designed for at least eight lanes of traffic, with provision for additional lanes in the future. To reduce congestion at bridge terminals, it is quite a simple matter to carry the traffic on elevated or depressed structures from the terminals to wherever desired. The plan for the new roadway at the Queensboro Bridge provides for such diffusion of traffic. After passing over the Manhattan Bridge, rapid transit traffic is now carried through tunnels.

For bridges over the narrower waterways, at least six traffic lanes should be built. If these bridges form part of an arterial highway, eight lanes are recommended, and in no case should the width of the roadway of a bridge be less than that of the street on either side.

The Department of Plant and Structures has control, including design, construction, and maintenance, of all the bridges over navigable streams within the City of New York, amounting to 52 bridges, and, in addition, four viaducts in the Borough of Manhattan. The Commissioner of the Department of Plant and Structures is the Hon. Albert Goldman, who has held that office since January 1, 1926.

Detroit Builds Highways for the Future

Metropolitan Plan for the Center of the Automobile Industry

By LEROY C. SMITH
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ENGINEER MANAGER, BOARD OF WAYNE COUNTY ROAD COMMISSIONERS, DETROIT

No municipal body has had a better opportunity to watch the monumental growth of motor traffic than has the Board of County Road Commissioners of the County of Wayne, Mich. During the past decade, the number and use of motor vehicles has developed with unforeseen rapidity, and it has been necessary to keep pace with this progress in the construction of highways and streets. The aim has been to synchronize one development with the other. In this article, Mr. Smith shows how Wayne County has solved this problem by developing, financing, and putting into operation the Detroit Metropolitan Plan.

As the automobile has been perfected, streets and highways have been improved to keep pace; and when additional street and highway facilities have been provided, additional motor vehicles have been sold. Thus the saturation point, so called, has been gradually raised. The number of automobiles now owned in the United States could not have operated on the streets and highways of twenty years ago, and conversely, the streets and highways now in existence could not have been economically utilized by the automobiles in existence twenty years ago. The development of one has been dependent upon progress in the development of the other.

In all the interrelated mass of statistics involving motor transportation and street and highway improvement, the City of Detroit and the locality centering in it hold a preeminent and unique position. As the center of the motor vehicle industry, Detroit and Wayne County have an obligation to themselves and to the world—an obligation to take the lead in the further development of the industry.

In 1930, Wayne County had 550,000 motor vehicles, and the ratio of automobiles to persons was 1:3.5. In Los Angeles, this ratio was 1:2.4. These statistics indicate that in Wayne County the saturation point for the use of automobiles has not yet been reached.

WOODWARD SUPERHIGHWAY, DETROIT TO PONTIAC
Right-of-Way 200 Ft. Wide, Highway 13 Miles Long

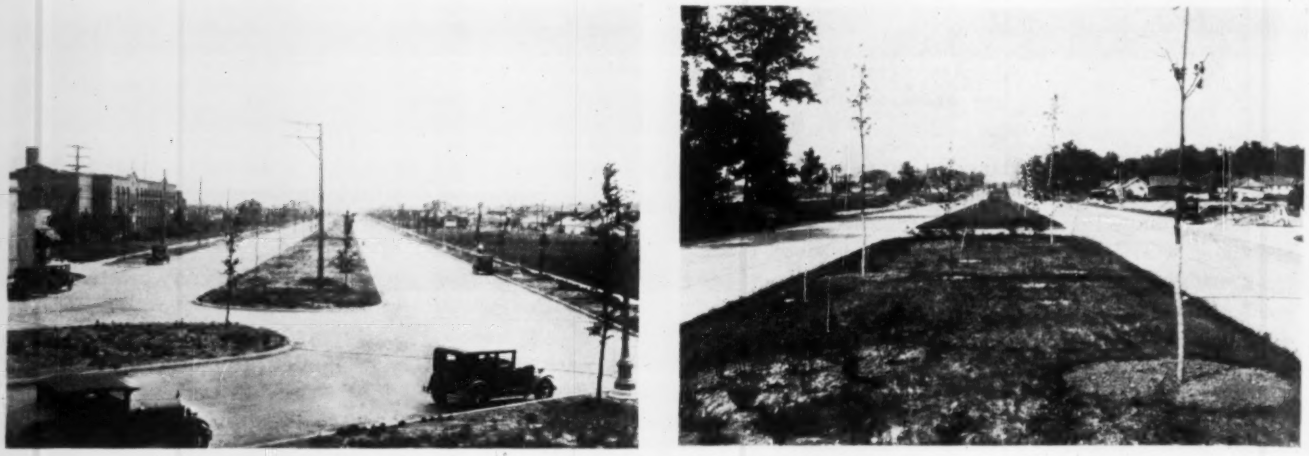
INAUGURATION OF COUNTY ROAD SYSTEM

Since 1906, the Board of Wayne County Road Commissioners has been working and planning to prepare the highways for the great flood of modern motor traffic. In the early days, the pioneers in the cause of paved highways for the environs of Detroit were considered visionaries. At that time the toll highways on the various important spokes of the wheel had worn out and were not being maintained, owing to failure of the companies. Outbound traffic was met at the city limits by impassable mud.

When the County Road System was inaugurated, an initial appropriation of $87,000 was secured, to be used in improving a dozen different highways. No funds were available for equipment or machinery. During those early years, the Wayne County Road Commission developed and adopted concrete as a standard for road construction. Now the concrete road has become the standard for the United States and many foreign countries.

Today, 25 years after it was started, the Wayne County road system reaches every city, village, and hamlet in the county. It embraces 600 miles of paved highways, ranging in width from 40 to 60 ft. within the 15-mile metropolitan radius, down to a 20-ft. minimum in the rural sections. It includes 40 grade separations at railroad crossings, 4 highway grade separations, 3 major bascule bridges, 90 other highway bridges, and safety systems including 243 stop-and-go lights. In addition, 50,000 shade trees have been planted in connection with the work for the beautification of the roadside; and 6 roadside parks and 10 comfort stations have been provided. The purpose behind all this work has been to serve the motoring public, keeping inconvenience and congestion at a minimum.

The 1931 annual program calls for 1,000,000 sq. yd. of pavement, 10 grade separations, 6 highway bridges, 8 miles of construction on the Rouge River Valley Parkway, 25 miles of wide right-of-way, and the annual expenditure of $10,000,000. All this could not be accomplished without a plan. The original plan of 1910, which called for 300 miles of county roads, has had to be supplemented by new routes required by the unprecedented growth of traffic. Now the county road plan embraces one half of all the public highways within the county.



East from Gratiot Avenue

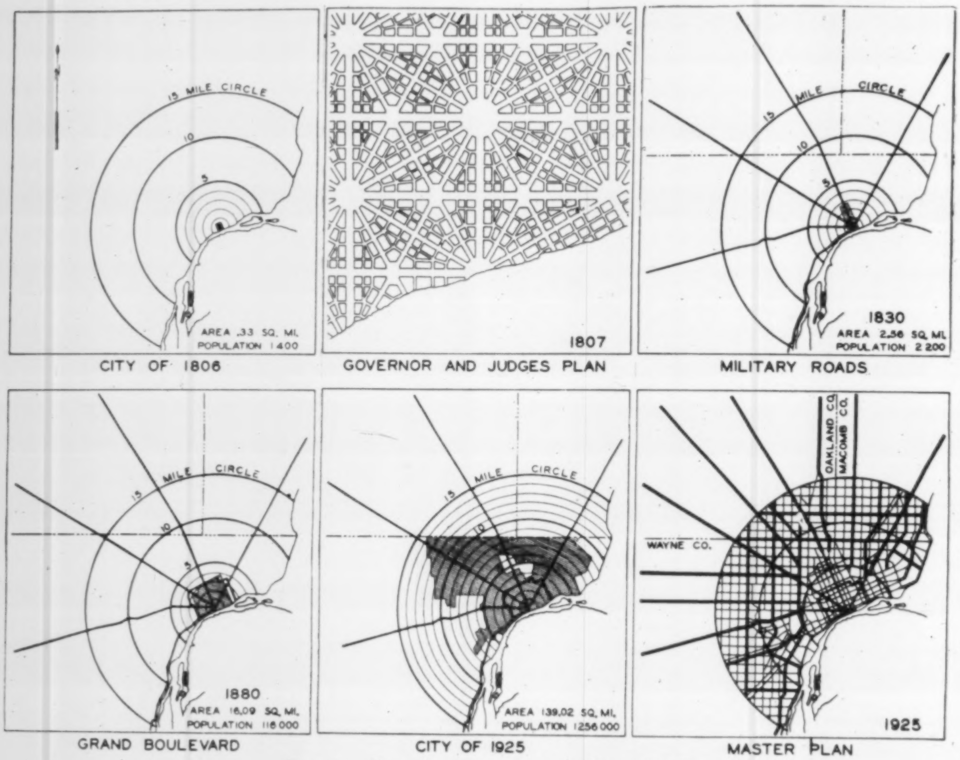
North from Schoolcraft Road

OUTER DRIVE; RIGHT-OF-WAY 150 FT. WIDE WITH TWO 36-FT. CONCRETE ROADWAYS

Legislation, recently enacted, provides that every public highway in Michigan shall become a county road or a state highway, and there will thus be no local or township highways.

GOVERNOR AND JUDGES PLAN

Detroit first had a plan in 1807, when the population was 1,500. This first plan, known as the Governor and Judges Plan, called for 200-ft. avenues spaced at intervals of 4,000 ft. in a north and south direction, and at 2,000-ft. intervals east and west. At the intersection of these major avenues, circles with a radius of 500 ft. were planned. Each quadrant so formed was further divided by two secondary radial 120-ft. avenues.



CITY OF 1806

GOVERNOR AND JUDGES PLAN

MILITARY ROADS

GRAND BOULEVARD

CITY OF 1925

MASTER PLAN

FIG. 1. DEVELOPMENT OF THE DETROIT PLAN
1806 to 1925

Washington Boulevard, Cadillac Square, the Campus, and Grand Circus Park are notable remnants of this 125-year-old city plan. Grand Circus Park is the south half of one of the 500-ft. circles, which was originally designed as a park and still remains as such. Modern city planners would call this park a traffic circle. If this plan had been adhered to, Detroit would not have a traffic problem today. But before long, this well balanced project for the city was abandoned and streets were laid out as we now see them, without reference to, or conformity with, the plan.

In 1830, Governor Cass, with the authority of Congress, laid out the following five military roads, each 100 ft. wide: West Jefferson (River) Road, to Toledo; Michigan Road, to Fort Dearborn; Grand River Road, to Lake Michigan, at the mouth of Grand River; Woodward Road, to Fort Saginaw; and Gratiot Road, to Fort Gratiot, now Port Huron. On account of their importance, these highways changed the design of Detroit to the "spoke-of-the-wheel" plan. Today 90 per cent of all the population of the Southern Peninsula of Michigan is concentrated along these routes. Although they were laid out by military authority, their commercial importance is predominant.

Each one of these arteries has been encroached upon and reduced to a width of 40, 66, or 72 ft., as someone's whim has dictated. If no encroachment had been permitted, Michigan and the City of Detroit would have been saved millions of dollars in road- and street-widening costs. As the city expanded, subdivisions with streets unrelated to adjoining properties have been permitted to be recorded, until the street system of Detroit has become a hodge-podge of jogs and narrow ways.

About the year 1880, when the City of Detroit had a population of not over 125,000 and its area did not exceed 16 sq. miles, a right-of-way 150 ft. wide was secured for a boulevard around the city. This avenue, called Grand Boulevard, is 12 miles in length, and encircles the city at the 3- to 4-mile radius. Its route was originally through pasture lands and its use was confined principally to horse racing. The right-of-way was considered unnecessarily wide at that time, but it has since proved its usefulness. In fact, last July, the maximum traffic in the city, amounting to over 75,000 vehicles per 24-hour day, occurred at the intersection of Grand Boulevard and Grand River Road.

THE NEED FOR A MASTER PLAN

During the last 125 years, the difficulty has not been a lack of plans for street and highway development, but rather a lack of enthusiasm for the carrying out of the good plans which were available. No plan is useful unless it is followed. The short sections of the wide avenues of the Governor and Judges Plan that are left in the downtown district have made it possible for civic, financial, and commercial activities to continue in their original location as the city has grown away from the Detroit River.

It seemed impossible that the great City of Detroit, through lack of foresight, should fail to provide for the flood of traffic developed by the product of its own industry. Yet this was actually about to happen. The situation was faced squarely, and in 1925, through the good offices of the Rapid Transit Commission of Detroit, the authorities in charge of streets and roads in the metropolitan district were brought together to study and decide upon a master plan for the environs. The plan adopted calls for thoroughfares and superhighways laid out so as to provide a 120-ft. highway on each section line, and an 86-ft. highway on each quarter-section line. It further provides that at intervals of 3 miles there shall be a 204-ft. superhighway.

In the outlying territory, the execution of this plan has been rapid under the direction of the superhighway commissions of Oakland, Macomb, and Wayne counties. These counties are voluntarily bound together by the provisions of the Darin Act passed by the 1925 legislature. This act provides that two or more counties may contract jointly to carry out a regional plan for highways. They may acquire dedications for the necessary rights-of-way, regulate permits for building along proposed routes, make joint surveys and plans, and take land for highways by dedication or purchase.

In five years, under the jurisdiction of the joint superhighway commissions, more than one-third of all the rights-of-way required by the plan have been obtained, of which nearly 80 per cent have been dedicated under the provisions of the law, as new areas were subdivided. Thus the outer metropolitan area is rapidly realizing a master plan system of thoroughfares, which not only provides for present traffic needs but also, because of the width of right-of-way available, for those of the future. Within the city, the greater difficulties and greater costs of readjusting street lines, by reason of higher land values and more concentrated building developments, has resulted in slower progress.

DETROIT INFLUENCES TRAFFIC FOR FORTY MILES

In order to show the greater need for street capacity near the center of great cities, a study was made of the traffic on five major trunk lines approaching Detroit—Fort Road, Michigan Avenue, Grand River Road, Woodward Avenue, and Gratiot Avenue—the highways that were laid out by military authority one hundred years ago.

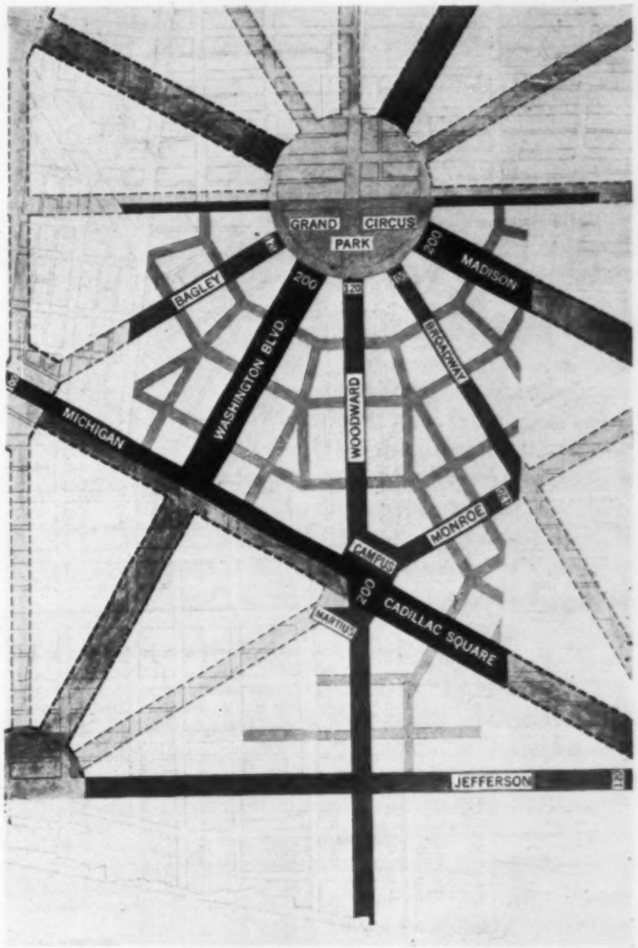


Fig. 2. Part of Governor and Judges Plan
All That Is Left of the Plan of 1807

Results of this study, showing the composite total traffic on these five thoroughfares, may be tabulated as follows:

Distance from Center of City	Number of Vehicles
4 miles	170,000
5 miles	168,000
10 miles	103,400
20 miles	61,200
30 miles	40,400
40 miles	31,500
50 miles	35,000

This count illustrates the fact that the city's traffic influence extends out approximately 40 miles. Beyond that point, the influence of other cities exceeds that of Detroit. Further, the traffic is nearly three times greater at a 4-mile radius than at a 20-mile radius. All these data point to the necessity of supplying downtown De-

SEVEN MILE ROAD
Looking West from Mt. Clemens Drive

troit with great highways if this area is not to be blighted by lack of automobile facilities.

Ten great superhighways have now been built in the three counties of Wayne, Oakland, and Macomb. Two-thirds of all the rights-of-way have been acquired, and over half the mileage is provided with adequate paving. Since all those routes converge toward downtown Detroit, the Wayne County Road Commission believes that they should be extended into, and connected across, the city proper.

A forward-looking plan to accomplish this end was the subject of a recent report to the Board of Supervisors, and the report and plan have been adopted in principle by the Wayne County lawmakers. This plan calls for the widening of unimportant streets through the unprosperous area of old Detroit to provide new 204-ft. traffic thoroughfares. By means of 61 miles of such highway, all the outlying superhighways will be connected to a downtown loop approximately one mile square.

We believe that such a plan is necessary to preserve the present high property values of downtown Detroit and to secure continued prosperity in the congested sections. It is not intended to supersede the city's master plan nor the state trunk-line route, but to parallel and supplement them, thereby caring for through traffic and making more accessible the districts where business interests are now well established.

This system of street widening in stagnant sections, where lots and buildings are of little value, will tend to increase values along the new thoroughfares. Wide highways will always attract the highest type of developments, and they will determine and fix the center of business in a rapidly growing city.

As buildings are carried to greater heights, with the resulting tendency to exclude sunlight and air from the lower stories, these broad thoroughfares will acquire an increasing importance entirely aside from their usefulness as travel ways of great capacity.

PAYING FOR THE ROADS

It is computed that all this can be accomplished without a great bond issue, on a pay-as-you-go basis.

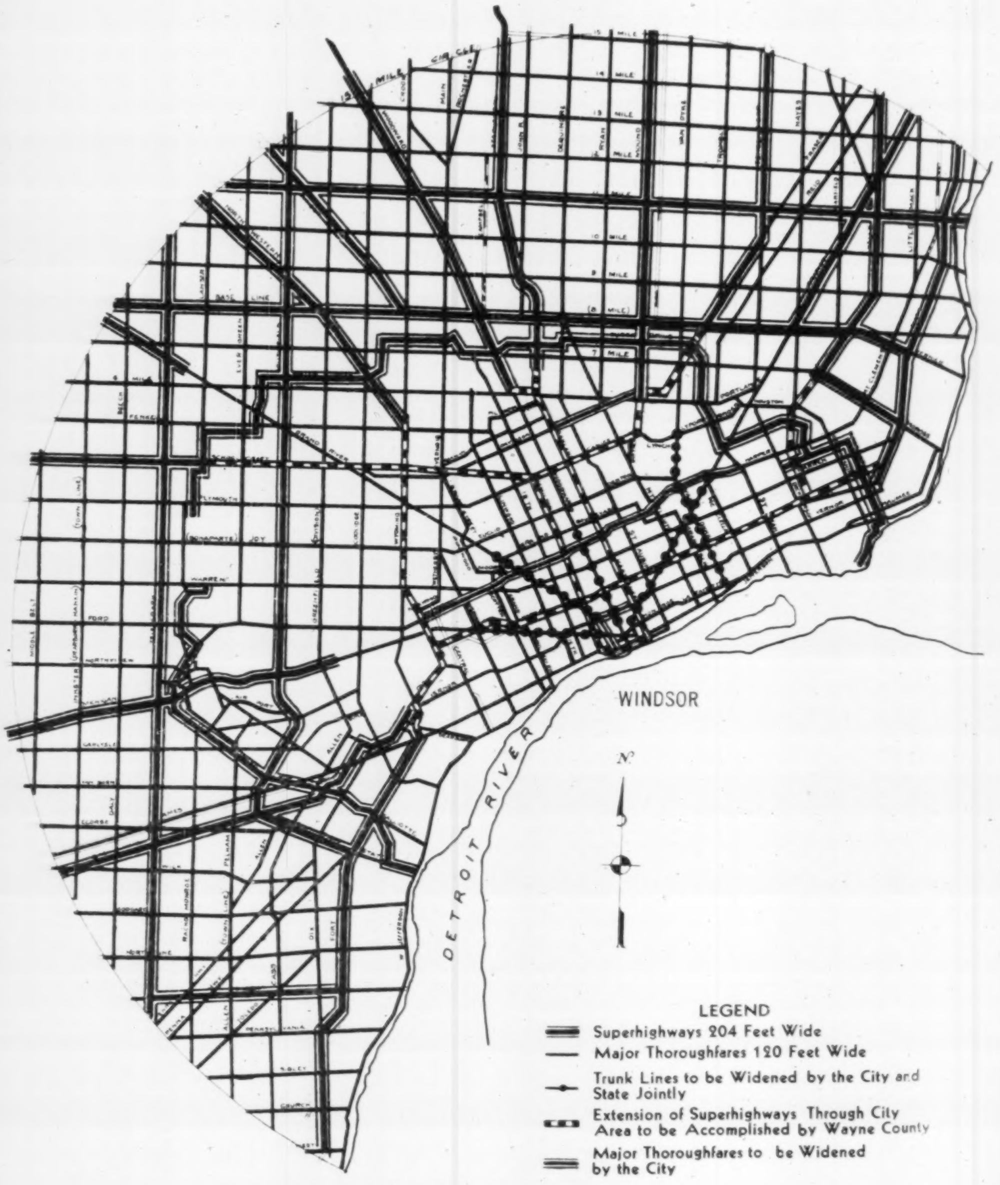

WINDSOR
DETROIT RIVER
N
LEGEND
Superhighways 204 Feet Wide
Major Thoroughfares 120 Feet Wide
Trunk Lines to be Widened by the City and State Jointly
Extension of Superhighways Through City Area to be Accomplished by Wayne County
Major Thoroughfares to be Widened by the City

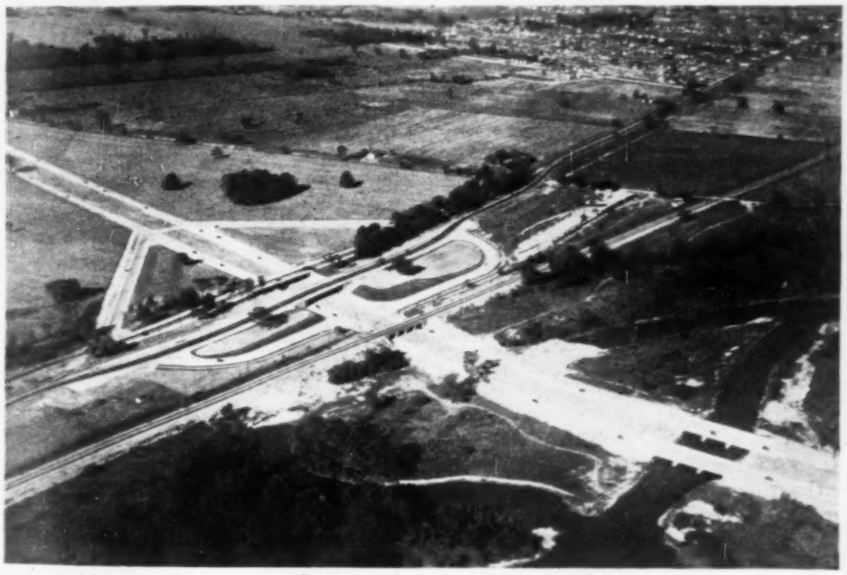
FIG. 3. MASTER PLAN FOR DETROIT AND ENVIRONS
Proposed for City, State, and Wayne County, January 1931

Wayne County has so far been successful in meeting her road obligations annually by means of a 1-mill property tax and one-half the weight tax collected in the county. If the county road tax were increased to 2 mills, the whole plan could be accomplished in ten years.

If and when Detroit needs rapid transit facilities, the wide rights-of-way will be useful for economical construction. Meanwhile, the express highways with local side roadways will be available for motor traffic, thereby encouraging the use of the vehicles which are the city's own product.

OUTER DRIVE DEDICATED

A 42-mile circumferential drive around Detroit, from the Detroit River to Lake St. Clair, and similar to the Grand Boulevard, was laid out by the City Plan Commission in 1915. At the time it was designed it occupied territory not a part of Detroit, but in a few years it was taken into the city. This great boulevard, called the Outer Drive, was adopted largely in advance of subdivision, and a width of 150 ft. was dedicated for it when plats were recorded. In 1925, it was taken over as a county road and its improvement was started. Of its total length of 42 miles, one-half is now completed, landscaped, planted, and lighted, with two 36-ft. pavements, and grade separations at railroad crossings. This highway serves as a pleasure drive, absorbing much of the automobile peak load. Trucks are prohibited.



Michigan Southfield Grade Separation, Air View

Two Superhighway Bridges, and Railroad Grade Separation, and the Rouge River Crossing

PARKS AND PARKWAYS

No discussion of metropolitan highways would be complete without reference to recreation space. An industrial center like Detroit is likely to place too much emphasis on the development of commercial highways and not enough on the preservation of beautiful and restful places for recreation purposes. Wayne County is still rich in natural beauty, and the stream beds which lead out through the county in winding routes are ideal for parkway development.

Fort Superhighway Crosses Four Railroad Tracks

40-Ft. Highways with Central Parkway, and Viaduct with 80-Ft. Roadway

An initial project has recently been started in the Rouge Valley, near Plymouth and Northville. The plan is eventually to include all the land along this stream from Detroit to Northville, from the top of the bank on one side of the river to the top of the bank on the other. This land is low and practically useless for farming, yet it can be developed into an ideal parkway, serving thousands of people.

At the present time, the most important requirement is to secure the necessary land. The plan includes a parkway drive following the stream through the low land, with grade separations at important highway and railroad crossings. Numerous areas along the drive will be developed for various recreational purposes. In no case, however, will the natural condition of the land be changed more than is necessary for needed improvements. Such a drive, winding through a valley flanked with wooded slopes and rolling hills, will be unequaled as a parkway development. It is planned to provide spaces for parking; to build comfort stations; to plant trees and shrubs; to change and deepen the river bed where necessary; to construct foot bridges, highway bridges, and bridle paths; to make provision for swimming pools, and for baseball, tennis, and other sports; and to light the entire drive.

In addition to its use as a pleasure drive, this development has been planned, by providing sufficient recreational facilities, to absorb a large amount of the traffic which is now scattered aimlessly on other roads in search of suitable areas for rest and relaxation. This service to the public in relieving congestion is very important, but the service to individuals in need of fresh air, sunshine, and carefree recreation, is incalculable in value.

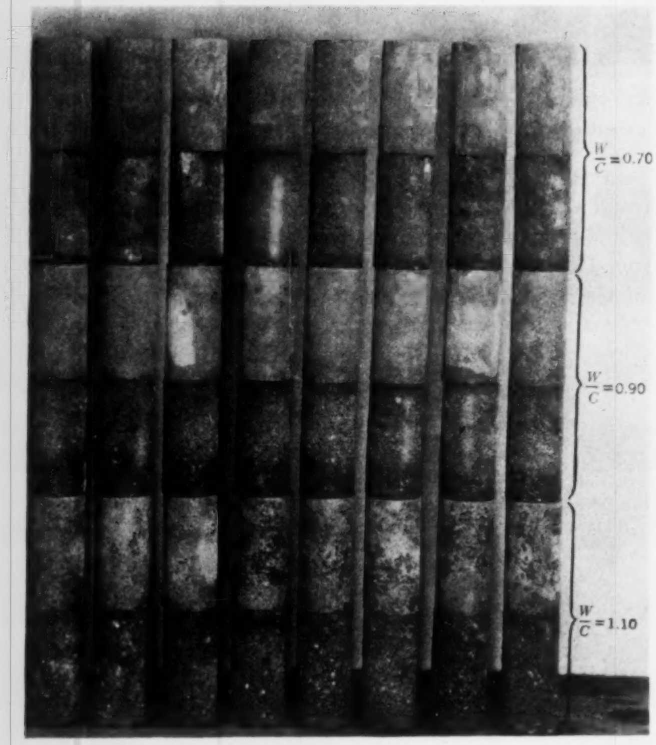
OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Construction Materials Should Be Specified

Dear Sir: I read with interest Mr. McMillan's paper on the "Basic Principles of Concrete Making," in the April issue. I believe that I am voicing the opinion of all who work with concrete when I say that the water-cement ratio is the basis of most, if not all, of the qualities of concrete—with the one restriction that a workable, plastic mix be produced.

Certainly we understand that intelligent attention to other phases of concrete making is necessary for obtaining good results. Proper gradation of aggregates, the careful preparation of surfaces for succeeding pours, proper placement of the fresh concrete, and timely and adequate curing, are all essential.



Effect of Exposure to Water on Concrete of Different Water-Cement Ratios

In spite of the establishment of the volume of water to the volume of cement required for the production of concrete of any required strength, there still remains considerable difficulty in applying the water-cement ratio to field production. I believe that most contractors would prefer to bid on concrete with a definite cement and aggregate requirement rather than on a water-cement ratio strength specification.

On a large dam job, involving 320,000 cu. yd. of concrete, the City of Seattle enforced the water-cement ratio with splendid success. After fixing the quality of concrete desired, both for strength and impermeability, trial mixtures were made from aggregate of a grading which represented the economic production from the source of supply. After the trial mixture was tested for strength, workability, and watertightness, a mix of 100 lb. of cement to 800 lb. of total aggregate, requiring 1.2 barrels of cement per cu. yd. and producing a workable plastic mix, with a water ratio of 0.75, was selected and specified. While the water ratio varied from 0.70 on cold, wet days to 0.78 in hot, dry weather, the results were very uniform and satisfactory. As the gradation of the aggregates changed according to the part of the bar from which they came, the weights of the three sizes specified were adjusted for uniformity. Consequently, if sand and intermediate aggregate were close to the fine limits, 220 lb. of sand, 320 lb. of intermediate aggregate, and 260 lb. of coarse aggregate might be specified; while, if the sand and intermediate aggregate approached the coarse limits, 240 lb. of sand, 350 lb. of intermediate aggregate, and 210 lb. of coarse aggregate might be specified.

The result of tests to determine the effect of 5 years of exposure to water upon concretes of different water-cement ratios is illustrated. Light-colored specimens were stored in water in hermetically sealed jars; dark-colored specimens were stored in tanks through which water passed at the rate of 2 gal. per min. In the specimens having a high water-cement ratio, the dissolution of the surface is much more pronounced.

I believe that it is the duty of the engineer to specify what goes into his construction work. If some such method of specification and control is used, the water-cement ratio requirement may be fully complied with and much controversy and contention between contractor and engineer avoided.

H. F. Faulkner
Junior Engineer, Department of Public Works of the City of Seattle

Seattle, Wash.
April 27, 1931

Does the Engineer Respond to Advertising?

Dear Sir: I have been interested in the report of the Society's Committee on Publications, published in the May issue of Civil Engineering, on page 750, and particularly in the statement of the aims in introducing Civil Engineering as a new periodical, on October 1, 1930, and the adopted policy toward advertising therein expressed.

In a journal of this type, advertising has a definite place, and the decision of the committee to offer space in it to advertisers was deemed wise and evidently has since proved so. The selection of editorial material for this publication places it definitely in the technical news class, and in such a periodical an important part of the technical news is the announcement of commercial products and facilities appurtenant to civil engineering.

There is an ever-increasing use of structural and mechanical appliances in all forms of engineering construction. A host of manufacturers supply these appliances. The progressive manufacturing organizations are working constantly in the development of new materials and appliances and in the improvement of the old. The progressive engineer is desirous of keeping abreast of these changes and improvements. One of the methods of presenting the facts about these products to the engineer, with the minimum expenditure of time on the part of all concerned, is through the medium of informative advertisements.

Advertising has a definite news value, equal in importance to the news and technical value of the articles in engineering publications. Engineers generally recognize this, and respond to advertising in proportion to its quality. I define response as critical appreciation, not the coupon-clipping, unimaginative acquiescence to the advertiser's request for a name and address.

I believe that no prejudice against honest, reliable advertising exists among intelligent engineers any more than it does among other persons of vision. My own experience tells me that manufacturers of engineering equipment have done much for consulting and designing engineers in the dissemination of information through descriptive catalogues and, in many cases, through booklets of real scientific value. This literature published by manufacturers forms a worth while addition to the technical library of the engineer.

Morris Knowles, M. Am. Soc. C.E.
President, Morris Knowles, Inc., Engineers

Pittsburgh, Pa.
June 5, 1931

Shall Civil Engineers Lose the Right to Design Buildings?

Dear Sir: The Board of Direction is to be congratulated for taking a definite stand at the Norfolk Meeting on the current issues in New York State affecting the engineers' rights to practice in the building field. This forward step is of immediate national concern to our profession. The national association of architects—the American Institute of Architects—has, in its publications, persistently favored the registration of architects. Repeatedly the publications have stressed the value of such registration and have informed their readers how they should proceed to secure it and to maintain it inviolable. Doubtless, under the influence of such a stimulus, the local chapters in New York State have taken vigorous action.

In New York State, the local architects have, until now, successfully maintained on the statute books discriminatory legislation against engineers, depriving them of their legal right to act as principals for clients in preparing plans for building construction. The specific measure which started this controversy was enacted in 1929, and is known as the Multiple Dwellings Law. Section 300 of this law provides that only owners in person or registered architects acting as their agents may file plans with the New York City Tenement House Department. In order to rectify this injustice, the New York State Society of Professional Engineers, cooperating with other local and national engineering organizations, sponsored corrective legislation during the present session. Most of the local discrimination against the engineering profession would have been removed had these measures become effective.

From my intimate contacts with architects, builders, and manufacturers, I am aware that the New York State architects have long prepared a careful campaign to carry their program through at all costs. They view a temporary defeat only as a minor setback, which will in no way interfere with their fixed program of devising ways and means to reassert their "pre-industrial" status in maintaining complete control of all building operations.

Nationally, their major objective is to eliminate engineers from active, directing positions on important public bodies and commissions dealing with such matters as zoning, city planning, airport development, public works, and supervision of all building design and construction. Locally, their efforts in New York City and State are concentrated on accomplishing the following:

1. A revision of the building code so as to avoid direct examination of their plans for all buildings by the professional civil engineers in the various city building departments.
2. Ultimate and complete abolition of the Bureau of Buildings, and transference of its duties, partly to the Tenement House Department and partly to the Board of Standards and Appeals, to be administered by architects.
3. Formulation of such provisions in new or revised building codes as sponsored by members of their organization jointly with certain groups of so-called "structural" engineers, wherein only architects and "structural" engineers are recognized as the sole authorities on all matters pertaining to the safety of building design and construction.
4. Removal of the responsibility of planning and directing the construction of the state's buildings from the Department of Public Works, which is now composed of professional engineers and directed by a chief engineer. It is intended to transfer its duties to a Fine Arts Commission, to be administered by architects. Attempts were made to pass such laws during the past two legislative sessions and, were it not for the Governor's veto, such laws would have become effective in 1930.
5. Promulgation of extensive publicity campaigns in the public press presenting statements which would lead the public to believe that the architects are doing all the work involved in planning and predetermining the safety of tall skyscrapers, such as the Empire State, the National City Bank, and the Chrysler buildings. In a recent series of articles, graphic descriptions were given of supposed interviews with architects ostensibly engaged in making intricate computations for determining the sway of the tall buildings, whereas as a matter of fact they were engaged with charcoal renderings, with wash drawings, and with plaster models.

No prophetic vision is required to foresee that the issue of "Architect—Not Engineer" vitally affects the engineers' future professional status, in that the architects' success in maintaining discriminatory legislation will mean the virtual abdication to architects of our professional rights. Though the issues have been forced on us against our will, we cannot, either individually or collectively, escape our clearly defined duty to maintain the solidarity and rights of our profession. Each member of the Society owes it to himself to urge the Board of Direction to give this subject careful consideration for the purpose of adopting measures to counteract attempts to exclude engineers from any legitimate field of practice.

Morris Kampf, Assoc. M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
May 20, 1931

Winter Work on the Railroad

TO THE EDITOR: I am reminded by Mr. Taylor's paper on "Twelve-Month Construction," in the January issue, of the winter work done on the Missouri Pacific Railroad. In 1925, we began double-tracking the line, reducing grades from 1 to 0.3 per cent, and correcting the alignment. Since then this has been continued without interruption. Concrete has been placed at temperatures below zero. Occasionally some thin slabs and curb work have frozen, but it is only a very small percentage of the concrete placed in freezing weather that has given any trouble at all.

The tunnel at Gray's Summit was lined when temperatures on the outside were as low as 15 deg. below zero. By protecting the tunnel at the ends and using a wooden framework bulkhead inside, it was possible to maintain a reasonably good temperature within the tunnel. At any rate, we have been able to work continuously for the past five years and intend to continue with this program of twelve-month construction.

E. A. HADLEY, M. Am. Soc. C.E.
Chief Engineer,
Missouri Pacific Railroad

St. Louis, Missouri
April 22, 1931

In Defense of the Engineer's Mathematical Training

TO THE EDITOR: In Mr. Merriman's article, "Logic in Engineering Diagnosis," in the April issue of CIVIL ENGINEERING, he says that "logic is the science of concepts as means to an end, yet no pure concept is valid until it has been proven by the results of observation." This would seem to imply that we can change our logic to suit experimental results, as a politician changes his opinions to suit the exigencies of the time. We might, then, entertain the proposition that experimental proof of the fact that two times two is something different from four might be obtained.

Again, the author says that, "That which is entirely logical to one man may be wholly illogical to another." However, it is stated by Karl Pearson in *The Grammar of Science*, third edition, Part 1, page 19, that the characteristic of scientific reasoning is that it is free from personal bias. So Mr. Merriman must mean by "logical" something different from the ordinary meaning of the word.

It should be kept in mind that, when experience and reasoning clash, reasoning prevails, because it imposes itself upon our understanding, while the results of experience can always be explained away. An example may be taken from Poincaré's excellent book, *The Foundations of Science*, published in New York by the Science Press. Assume that we have some weights, $A, B, \ldots E$, and that, by weighing these on the most sensitive scales available,

$$A = B;\ B = C;\ C = D;\ D = E \ldots\ldots [1]$$

On removing D from the scales and weighing A against E, we find that

$$A > E \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

These two equations are the result of observations made with the most sensitive scales devised. Yet, we reject this result because it does not fit into our mode of thinking since, from Equation 1, we conclude that $A = B$. We not only reject the results of the most carefully made direct observation, but we furnish the explanation out of our own imagination—that is, that the discrepancy between Equations 1 and 2 is due to the circumstance that $A, B, C \ldots$ are not exactly alike, but that their differences are so small that our scales cannot register them, whereas the accumulation of all these minute differences appears when we weigh A against E.

The confusion existing in Mr. Merriman's analysis is particularly well brought out in his statement that "few, if any, of the formulas now in existence actually express ultimate truth because none is wholly logical." The "ultimate" is borrowed from theology and has no place in natural science, where it cannot even be defined. A scientific hypothesis, as Poincaré says, is valuable not in proportion to its truth, but in proportion to its usefulness. The atomic theory has been and still is immensely valuable to chemistry, but we have known for a long time that it contains nothing of ultimate truth. The "ultimate" composition of matter we believe today to be electrical, and matter and energy are two names for much the same phenomena.

Also, Mr. Merriman states that "the mathematical analysis of a structure like a dam is not at all susceptible of complete demonstration," and that "no such analysis can possibly be as valid as the assumptions on which it is based." But no one who is trained in, or understands, mathematics believes that a mathematical or any other analysis can be complete. No two instances are exactly alike, but science is made possible by the neglect of those factors which there is reason to believe are of minor importance. On the other hand, an analysis, correctly made, is just exactly as valid as the assumptions on which it is based.

What I wish to bring out is the fact that the error which Mr. Merriman would like to lay at the door of the mathematician—his imputed belief in mere formulas—is not characteristic of the mathematically trained but, on the contrary, is characteristic of those who lack mathematical training and regard formulas as complete and infallible.

B. F. JAKOBSEN, M. Am. Soc. C.E.
Consulting Engineer

Los Angeles, Calif.
May 26, 1931

The Qualifying Authority Must Also Be Qualified

EDITOR: It is evident from the symposium on the prequalification of contractors, in the January issue, that contractors should be qualified before they are allowed to bid. The private owner always prequalifies his contractors or his prospective bidders in one way or another. The public authority would also like to do this, but has not always been able to. However, it is infinitely easier for it to deal with prequalified contractors than to postqualify them after the bids are made, as has been mentioned in recent articles in CIVIL ENGINEERING. The system is simply a measurement of contractors' abilities. There is a possibility, as has been developed, of prequalification along general standards, but those would have to be modified in specific cases.

On the other hand, some dangers are present in any qualification of contractors. To protect the trustworthy contractor from the unscrupulous one, we must first avoid placing the qualifying authority in equally unscrupulous hands. It is entirely possible, as has been the case in many communities where the qualifying authority was a politician and the evils of political qualification resulted, that only political favorites could get public work. However, some successful steps in the right direction have been made by referring the qualification to a professional man and then having it passed on by a board.

My own experience with prequalification is in connection with the development of highway work. Twenty-five years ago there were very few highway contractors. Then it became necessary to develop this branch of activity and to get men to compete for contracts on highway work. If the qualification is too severe, no contractors will, in years to come, undertake highway work. If new men are not allowed to come into the field, the existing firms will gradually disappear, and there will be no competent highway contractors. Consequently, in any qualification one must avoid extremes.

W. W. Crosby, M. Am. Soc. C.E.
Consulting Engineer

Coronado, Calif.
June 20, 1931

Bonding Companies Could Qualify Contractors

Dear Sir: The papers on prequalification of contractors, published in the January issue of Civil Engineering, touch upon a very important question, and one that has received a great deal of discussion in the profession.

I have felt for a long time that some means of qualifying contractors is highly desirable. At the present time, it is very difficult for public officials to turn down a bid when the contractor is able to supply the necessary bonds from a responsible bonding company. The matter would be simplified considerably if a contractor who was not qualified to handle a job in question were unable to make bond. I think the bonding companies and their engineering departments are probably more familiar with the qualifications of different contractors than any public board ever could be, even after a careful investigation.

The papers referred to have convinced me more thoroughly than ever that, if bonding companies would refrain from writing bonds on every contractor who can put up the necessary collateral, the situation would solve itself. Although I am aware of the desire of the different bonding companies to obtain business and of the competitive situation among them, I have always felt that unified action was a reasonable possibility. Action on their part would certainly eliminate irresponsible and unreliable contractors, which is the result desired. It is undoubtedly necessary to give public officials some definite and positive reasons for disqualifying a bidder, and the action of such public officials cannot be handled in the manner in which such matters are taken care of by private corporations. So it is my own belief that the best way to bring about the results desired is to make it more difficult for contractors not fully qualifying from the standpoint of finance and experience to obtain bond.

N. T. Veatch, Jr., M. Am. Soc. C.E.
Black and Veatch, Consulting Engineers

Kansas City, Mo.
May 25, 1931

Circular Caisson Piers

Editor: The paper by Mr. Newman, in the January issue, suggests several thoughts on the subject of sinking caissons.

On the Lower Mississippi River, in connection with the construction of the Federal Barge Line's river terminals as well as on other private projects, we have constructed a number of circular caisson piers to a depth of 120 ft. below the river bank and about 40 ft. below the river bed. These cylinders were of reinforced concrete construction, circular in section, with walls about 2 ft. 0 in. and 2 ft. 3 in. thick, and with outside diameters of 10 and 12 ft. A steel cutting edge, fabricated from plates and shapes, was provided and riveted to the steel shells of the caisson, which also acted as a form for concreting the lower sections. The caissons were sunk through sand and an occasional thin layer of blue clay, by means of jets along the cutting edge and sides and by excavating with clamshell or orange-peel bucket from the inside. As the caissons were sunk, weight was provided by adding additional concrete sections at the top. Occasionally, a small amount of dynamite was exploded on the inside at the cutting edge whenever the caissons ceased to go down.

On one project, extreme high water was experienced. To prevent being overtaken by the river, the contractor materially lowered the water level on the inside of one of the caissons in order to speed up the excavating and sinking. He was successful in this procedure until the head of the water between the inside and outside of the caisson was about 80 ft., when a "blow-in" under the cutting edge resulted, causing the caisson to be thrown out of plumb 12 in. one way and 17 in. another, also forcing some 40 ft. of material up on the inside. We found it practically impossible to bring the caisson entirely back to its correct position. To prevent further "blow-ins" under the cutting edge, the water level on the inside of the caisson was kept above the outside level. This procedure, of course, slowed up the process of excavating but eliminated any further "blow-ins." Materially lowering the water level on the inside of a caisson, when sinking it through sandy material as encountered on the Lower Mississippi River, is an extremely hazardous proposition and should not be permitted.

Sinking of these caisson piers was conducted by excavating on the inside through water by means of a clamshell or orange-peel bucket, or with a suction dredge, the capacity depending on the space available in the caisson. In the case of dredging, it is necessary to pump water back into the caisson in order to maintain the same, or a higher water level inside the caisson than exists on the river, to prevent "blow-ins" under the cutting edge.

Walter F. Schulz, M. Am. Soc. C.E.
Consulting Engineer

Memphis, Tenn.
May 16, 1931

Model Tests for Spier Falls Plant

Dear Sir: In Mr. Hogan's paper, "Record Hydro-Electric Turbine Installed," printed in the March issue of Civil Engineering, mention is made of the model tests performed at the Alden Hydraulic Laboratories of Worcester Polytechnic Institute in connection with the design of the recent addition to the Spier Falls plant. Some additional information on these tests may be of interest. As stated in Mr. Hogan's paper, the primary object of the model tests was to determine the economical size of the forebay, which had to be enlarged on account of the very substantially increased capacity of the plant.

In determining the scale of the model and the material of which it had to be constructed, advantage was taken of the data contained in the papers on model testing, published in *Hydraulic Laboratory Practice*, edited by John R. Freeman, Hon. M. Am. Soc. C.E. A thorough study of the problem indicated that the use of a scale of from one-quarter inch to one inch to the foot would give good results if the rough, rock-cut perimeter of the prototype was represented in the model by a fairly smooth surface, such as would correspond to Kutter's coefficient, $n = 0.017$. This was obtained by the use of concrete made of sawdust and cement, troweled smooth to the neat lines of the proposed cross section.

The intake and the transition made from the intake to the circular penstock of the new Spier Falls unit is of complicated design, as can be seen in Figs. 2 and 3. In the design, an effort was made to accelerate the water in a uniform manner from the forebay through the intake and transition into the penstock in order to avoid, as far as possible, losses due to shocks and eddies. However, because of structural requirements, the smoothness of the flow could not be completely insured, and it was thought advisable to test the efficiency of the intake by model tests, with a view to making such changes in the original design as might be indicated by the results of these tests. A model of the intake, transition, and penstock was therefore built in with the model of the forebay in such a manner that the dimensions of the water passages could be varied. The model tests showed that some changes conducive to both economy and reduction of head losses should be made in the original design, and these changes were incorporated in the final layout.

Since Mr. Hogan prepared his paper, actual measurements have been made at the Spier Falls plant to determine the losses in the passage of the water from the forebay to the turbine. These measurements show that the results obtained from the model tests varied only from between one-quarter of an inch to three-eighths of an inch from the actual losses occurring in the plant, which amount to between 4 in. and 9 in., depending on the volume of water used. I feel that the expenditure of money and labor in the testing of the intake was well worth while.

The design of the model, its construction, the testing, and the computations of converting the results to the full-sized structure were made by C. L. Avery, under the guidance of S. O. Schamberger, Assoc. M. Am. Soc. C.E., and at my advice.

EUGENE E. HALMOS, M. Am. Soc. C.E.
Chief Engineer, Parklap Construction Corporation

New York, N.Y.
May 30, 1931

Spier Falls Development Operating Successfully

DEAR SIR: In connection with the Spier Falls installation, described by Mr. Hogan in the March issue, the following points may be of interest.

No. 9 unit, mentioned by Mr. Hogan, was put into active service during the early part of December 1930, and since that time has been in daily use, operating on a short-hour schedule because of the low stream flows, but carrying from three-quarters of a load to a full load during its actual use.

Field tests have been substantially completed, and the results parallel with surprising closeness the expected results obtained from the model tests. Since the middle of December, when the unit was turned over to the operating department, no difficulties have been experienced, and its performance has met all expectations.

The article by Mr. Hogan did not touch on the electrical layout. This was simplified to the maximum extent by eliminating all oil switches except a single high-tension breaker between the 110-kv. side of the transformer bank and the high-tension bus. The unit is operated with a grounded neutral through 200 ohms of resistance but, except for the extreme simplification, there are no unusual features in this part of the design.

Also, Mr. Hogan's paper does not bring out the results of his firm's efforts to produce a design which would simplify operating problems of maintenance and inspection. While the passageways in the substructure are simple, they are liberal in area and quite in contrast to the usual conditions which require access to the water-wheel scroll case and the draft tube through small openings and by means of ladders. The Spier unit provides easy approach, ample room for handling scaffolding and equipment, and complete freedom from any difficulties with water.

In addition to this, it is interesting to note that no difficulties were experienced with seepage or leaks through the concrete structure. Two leaks were found when water was first admitted—one at the junction between the penstocks and the scroll case, which was easily corrected by re-caulking, and the other, consisting of the collection of leakage from the scroll case, was in the passageway giving access to the draft tube. This leakage rapidly decreased in the first few weeks of operation, and at the present time is very small. Without doubt, it will completely seal before the year is out.

J. D. WHITTEMORE,
Executive Engineer,
New York Power and Light Corporation

Albany, N.Y.
May 19, 1931

Hydro-Electric Plants Adapted to the Landscape

DEAR SIR: I have read with interest, in the March issue of CIVIL ENGINEERING, the article by Mr. Hogan on the enlargement of the Spier Falls Hydro-Electric Plant, for which my firm were consulting architects. The illustration of the exterior shows the present addition, which is only three bays long and therefore has an unbalanced appearance. The design was made with a view to a future expansion to six bays and should, consequently, not be judged by its present aspect.

My firm was also privileged to act as consulting architects upon the Conklinsville project; but here again only a portion of the scheme has been built to date. When these two buildings are completed, we hope that they will show that such plants can, at a negligible increase in cost, be made interesting features of the landscape without detracting in any way from their efficiency.

LAWRENCE GRANT WHITE
McKim, Mead, and White, Architects

New York, N.Y.
May 29, 1931

Guarding Against Cracks in Gravity-Type Dams

Dear Sir: I have read with great interest the paper on "Honeycomb Gravity-Type Concrete Dams," by C. E. Grunsky, which appeared in your April issue, and am entirely in agreement with him as to the advantages of the method of construction to which he refers—as to the facility which this type affords for rapid cooling of the concrete, its freedom from uplift pressure, and its articulation. There are, however, three points of detail to which I should like to refer.

The possibility of uplift pressure on the base of the dam, that is, where it rests on the rock, is reduced by the vertical construction joints, but it would be an additional advantage to provide also for the drainage of any water which might percolate and be intercepted between the joints, by means of vertical pipes communicating with the drainage galleries illustrated in Figs. 1 and 3.

The figures are obviously intended merely to illustrate the general principles, but in designing the galleries it would be best to avoid any angles where the side walls and roof abut against the concrete at the water face. By rounding the end of the gallery so that the water pressure is transmitted to the side walls and to the roof through an arch, shearing stress or liability to crack can be minimized.

The design which shows the axis of the galleries at right angles to the resultant force, when the reservoir is full, appears preferable; and I consider that they should be kept open for inspection at all times and under all conditions, which would not be the case if they were filled with earth, water, or material.

A metal diaphragm is suggested to secure a watertight face. This diaphragm is shown to be protected from corrosion by a comparatively thin sheet of concrete. It appears to me doubtful whether this protection would be permanent, for the following reasons.

If the reservoir is drawn down so as to expose this surface concrete to the air for any length of time, the concrete will lose moisture. When the water level again rises, the concrete will absorb water and tend to expand; but as the water temperature is generally lower than the air temperature, the metal diaphragm will generally tend to contract, a considerable shearing stress being thus set up at the surface of separation.

In course of time, the concrete is likely to part from the metal and to crack, allowing a film of water to penetrate between the concrete and the metal, and when the reservoir is lowered, the pressure of this water may be sufficient to cause the concrete face to come away. There are several ways in which the face of the concrete may be rendered impermeable, and one method which my firm recently tried was to treat the concrete face with bituminous paint. The concrete should be heated by means of an air blast immediately before the application of the first coat so as to evaporate any moisture, and, as the temperature falls, the paint—if sufficiently thin—is drawn into the minute pores of the concrete. One or more additional coats of paint should then be applied, the number depending on the water pressure to which the face will be subjected. It was found, in the case referred to, that one additional coat was sufficient to prevent percolation under a head of 135 ft.

W. J. E. Binnie, M. Am. Soc. C.E.
Consulting Engineer,
Sir Alex. Binnie, Son and Deacon

London, England
May 8, 1931

A Weakness of the Gravity-Type Dam

Editor: The proposal of Mr. Grunsky, in the April issue, is worthy of consideration as well as instructive. This is especially true of the case illustrated by Figs. 2 and 3. A construction, such as that shown in Fig. 1, appears to me to be unsafe, as the horizontal joints represent critically weak places because of the danger of shear.

The filling of the galleries with water must be considered very carefully, because of the damage due to freezing that must be expected on the air side, and because of operating costs.

The natural shape of the honeycomb gravity dam is doubtless straight. But it cannot be stated, in a general way, that the straight form is the natural shape in all high gravity dams. If, in this case, grouting is done at the proper time through a carefully distributed system of cement grouting pipes, the curved shape can contribute to an increase in the safety of gravity dams.

Although Mr. Grunsky states that his proposal involves some increase in cost, he means that considerations of safety justify some lack of economy. I believe that safety and economy can be excellently combined. When we consider that every reduction in the cost of dams exerts a definite effect on the profit, we must consider every possible reduction in cost—especially with high dams.

The effort to secure economy together with safety has led to new types of dams, and revealed a weakness of the gravity type. This is the formation of cracks in the longitudinal direction as a result of contraction in high gravity dams. This formation of cracks, which Mr. Grunsky will also prevent by his new proposal, has only been recognized as extremely dangerous since the observation of cracks in the buttresses of dams that failed.

Giving to the proposal of Mr. Grunsky the consideration it deserves, I wish to ask whether, on the basis of the reasons indicated, the gravity dam is the safest type for very high dams? It seems to me that it is much easier, by precautions in design, to prevent dangerous cracks in the buttresses of buttressed dams than to prevent them in gravity dams.

Emil Probst, Prof. Dr. Ing.
Technische Hochschule

Karlsruhe, Germany
May 26, 1931

Importance of Superficial Eddy in Hydraulic Practice

Dear Sir: The article by Mr. Ewald on the prevention of erosion below overflow dams, in the March issue, is very interesting indeed. I am greatly surprised, however, to note that he completely ignores the superficial eddy which, although of varying volume, is always present where a change in flow from shooting to streaming or flowing occurs, as is ordinarily the case below a weir. The fact is that this superficial eddy is mainly responsible for the sudden drop of the energy gradient, as shown in Fig. 1.

Some writers have been rather careless in discriminating between hydraulic jump, standing wave, and flow change. The first, when originally discovered by Bidone, had nothing to do with the flow over a weir, but was observed when water of relatively high velocity struck water at rest in a basin. This gave a valuable check on the general equation for non-uniform flow in a channel. For a back-up condition, this equation indicates that, for a certain slope, the back-up curve disappears ($x = O$), and the rise in head takes place in one vertical section.

The standing wave is an unstable, hydraulic jump, usually preceding the jump—if it is experimentally produced as has just been described—immediately before the final slope is reached.

However, the flow change is what interests us most in connection with weirs. This is a modification of a hydraulic jump but should, for the sake of avoiding confusion, bear a different name. The Germans call it *Wechselsprung*, or change-jump, which is a very appropriate term.

In my discussion of "Baffle Pier Experiments on Models of Pit River Dams" (TRANSACTIONS, 1929), I derived an equation for the depth below a weir, which will give a superficial eddy of maximum efficiency. This was primarily in connection with curved dams, where the width of the channel changes between the crest and the toe. But the result, if properly modified, holds for straight dams as well.

The dissipation of energy without a superficial eddy is very small indeed, as the friction is small on smooth surfaces, particularly for shooting flow. Ignoring the significance of this eddy means, therefore, ignoring a feature which greatly affects the length of the apron, or, in other words, the cost of the structure.

Thus, the superficial eddy is a vital factor in theoretical hydraulics. It is formed by tailwater falling back and partly or fully filling the trough between the shooting and streaming flow. It is whirled around by the top filaments of the shooting sheet, thereby transforming the greater part of the kinetic energy into thermal energy, which is promptly dissipated in the air. For the prevention of scouring below the apron, the principal essential is to have the filament velocities distributed according to the flow in the natural stream.

PAUL BAUMAN, M. Am. Soc. C.E.
Chief Designer, Quinton, Code and Hill
—Leeds and Barnard

Los Angeles, Calif.
May 5, 1931

Protecting the Downstream Toe of an Overflow Dam

EDITOR: The paper by Mr. Ewald on "Preventing Erosion Below Overflow Dams," in the March issue, serves a useful purpose by focusing attention on the weak spot in so many overflow dams—the downstream toe. No design of such a structure is complete without expert treatment of this important feature, as constant trouble and expense result from neglect of the proper protection at the downstream toe. In recent years, however, intelligent study and analysis of the hydraulic jump have done much to simplify the problem.

Expressed briefly, the proposed remedy is to ensure a depth of tailwater sufficient to form the hydraulic jump close up against the foot of the overfall slope. If this depth of tailwater is not caused naturally by channel conditions, it may be obtained artificially either by depressing the toe or by lifting the tailwater by weirs, properly located, or by other means. When weirs are used, they should be looked upon simply as a method of forming the water cushion to cause the jump, and not in themselves as obstacles to flow. In other words, it is, the water cushion, not the weir, that causes the jump, the weir being simply a means to that end.

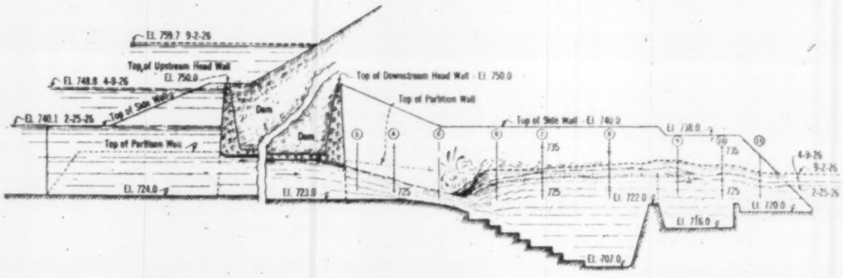
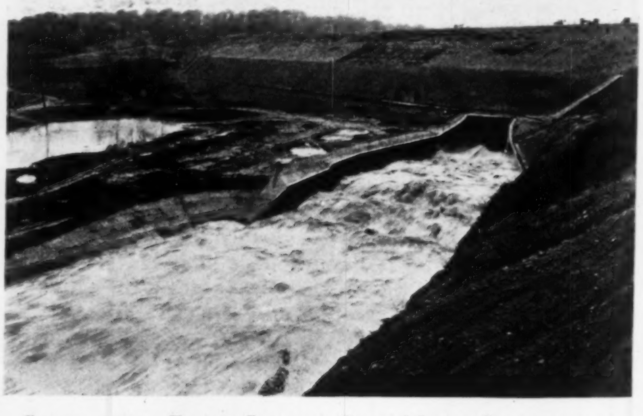


FIG. 1. GERMANTOWN DAM
High-Water Profile Showing Hydraulic Jump

The general principles outlined in Mr. Ewald's paper apply equally well to conditions at conduit outlets, where high velocities may be destructive to unprotected channels. In such cases, properly designed stilling pools, such as those used at the Miami Conservancy dams, have proved to be thoroughly successful. At the time of designing these dams, practical use was made of the hydraulic jump. Figure 1 shows the outlet of the Germantown Dam. For the details of this work the reader is referred to Parts 3 and 10 of the *Technical Reports of the Miami Conservancy District*, published at Dayton, Ohio. Ten years' use of these structures has demonstrated their adequacy. They have worked perfectly, and a recent examination of the stilling pool linings has shown that the wear has been negligible. Also, there has been no appreciable erosion in the river channels below the outlet structures.



GERMANTOWN FLOOD CONTROL DAM, MIAMI CONSERVANCY DISTRICT
Flood of 1926—Velocity at Outlet, 30 ft. per Sec.; Velocity at End of Stilling Pool, 6 ft. per Sec.

Considering the effect of vertical drops, as from outlets discharging above tailwater elevation, a cushioning pool is required of sufficient depth to prevent erosion; and here again the required depth may, if necessary, be secured by depressing the toe of the dam, or by other artificial means. My opinion of this action is that each accessible seam in the rock formation becomes filled with an effective wedge of water, to which the energy of the falling stream is readily transmitted. The fect is similar to that of breaking out blocks in a stone quarry by wedges and hammer, except that the water-hammer action is continuous and therefore more effective. In a shallow pool these blocks become dislodged, and the process continues until sufficient depth is developed to prevent further displacement. After this, friction comes into play in diminishing the effect of the wedging-out process.

CHARLES H. PAUL, M. Am. Soc. C.E.
Consulting Engineer

Dayton, Ohio
May 25, 1931

Features of the Min River Project

EDITOR: I have read with great interest the article by E. W. Lane in the February issue of CIVIL ENGINEERING, and I wish to bring my thoughts on the subject of the Min River irrigation project to the attention of the profession.

From August until October 1922, I traveled on a steamboat from Shanghai up the Yangtze River to Kwan-Hsien; from there I followed the old Chinese highway to Chengtu, capital of the western part of Szechwan Province. It was at this place that I heard for the first time, from missionaries, of the Min irrigation plant. Having always been interested in hydraulic works, especially in such far-away parts of the world, I did not hesitate to undertake a side trip up to Kwan-Hsien, which is situated at the head of the whole irrigation system.

The article by Mr. Lane is so clear and complete that I can only confirm his account of the different features of the system. I myself have published, in the August 1923 issue of the *Schweizerische Bauzeitung*, an illustrated article concerning the same irrigation system.

The way the Chinese explain the working of the first circular spillway, situated opposite the principal intake, is very interesting. On the crown of this spillway has been built a stone pedestal on which rests the bronze statue of a holy calf. At high water, a part of the inner river is forced to pass the spillway and to flow back into this original bed, at the same time making a roaring noise. The Chinese consider this noise as a protest of the holy calf, which is afraid of getting its feet wet. The spirits of the high water, which are thought to be of a lower order than the calf, then stop raising the water level and so the whole area beneath the intake is safe from floods. This explanation of the hydraulic function of a spillway is very typical of the mystic Chinese mind.

MAX WEGENSTEIN
Dipl. Ingenieur

Zurich, Switzerland
May 15, 1931

Regional Planning Commissions in California

EDITOR: In his article in the symposium on "Problems of a Large City," in the January issue, Mr. Greensfelder states that there are only 18 regional planning commissions now at work in this country. It may be a matter of definition, but it should be pointed out that in 1929 California passed a law requiring every county in the state—of which I believe there are 57—to create county planning commissions. The counties have already fulfilled this requirement—in some cases with considerable success.

A chairman of one of these commissions told me that the greatest difficulty he anticipated for his commission in the near future was convincing the supervisors, who control the appropriations for the work of the commission, of the feasibility of the scheme. Probably the best way to reach the county supervisors is through the electorate of the county. This means that the enthusiastic and far-sighted members of the county planning commission and the engineers connected with it must educate the people of the county. Therefore, I feel my responsibility as an engineer and a member of the Society—as I trust will everyone who looks forward to better living conditions in his city or community—for explaining patiently and in considerable detail what the planning movement is and what it hopes to bring about.

One point in Mr. Gephart's paper, in the same symposium, recalls an interesting book on the development of New York, which showed that the location of production centers, especially for retail trade, are frequently influenced by the location of the market or that of the probable purchaser. It may be of interest to someone to develop Mr. Gephart's theories a little further and try to locate the center of consumption of a region as well as the centers of population and production. This may perhaps be done indirectly by locating the center of income tax returns.

W. W. CROSBY, M. Am. Soc. C.E.
Consulting Engineer

Coronado, Calif.
May 22, 1931

Wind Bracing Connections Important

DEAR SIR: The annual progress report for 1930 of the Subcommittee on Wind Bracing in Steel Buildings meets with my hearty approval, with the exception of the first recommendation, regarding prescribed wind forces, and I suggest that this be amplified by giving special consideration to districts which are liable to extraordinary conditions, such as tornadoes and hurricanes.

In this connection it might be of interest to describe some of my own experiences in the St. Louis tornado of May 1896, pressures for which are discussed by Julius Baier, M. Am. Soc. C.E., in Vol. 36 of TRANSACTIONS. I was on the edge of the path of the tornado when it struck the city and was able immediately afterward to investigate the damage done. The most surprising thing was that the greatest damage had been done by suction. About six thousand buildings were either completely demolished or partly damaged, and in the great majority of cases the walls had fallen out. The roofs had been lifted off and carried away, and in some cases had been turned upside down on their own structures. I have still a clear recollection of the results of this storm, and it is that the effect of suction was paramount.

Comparing the St. Louis tornado of 1896 with the destructive hurricane in Florida in 1926, there seems to be one great difference. The Florida hurricane lasted for many hours, but in St. Louis most of the destruction was done in a few seconds, and the entire duration of the storm in the city was not over 15 min. Wind velocities up to 125 miles an hour were noted, but beyond this no records are available because the U.S. Government wind gage blew away. An entire freight train was lifted bodily from its tracks and carried sideways over 14 ft., and several huge blocks of stone which were on the flat cars were lifted and carried for distances of 20 ft. or more. These things I saw.

As to the question of pressure on large surfaces, I have observed, but without apparatus, the effect of heavy winds on buildings. By walking around them, it is quite evident that there is a great variation in the pressure, there being very little at about the center of the building, and an increase toward the ends.

The wind stresses in a building may be determined in the most careful manner, using accurate mathematical analysis or models, but still they may be unsafe, owing to poor detail in the framework connections. This is a matter that has a very great deal to do with the rigidity of a building. One has only to inspect construction work on high buildings in New York or other cities to be impressed with the fact that, while in some structures these details are very good, and have been designed with consideration for important factors, in others extreme incompetency is shown, due often to ignorance. I cannot stress this point too much—that the question of detail be given very careful consideration in the recommendations made by the committee. I am sure that when the report of tests of wind bracing connections—which I understand are now being made at the University of Toronto by C. R. Young, M. Am. Soc. C.E.—is published, there will be valuable data available to the engineering profession.

EUGENE W. STERN, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
June 8, 1931

Relation of Frequency Studies to Wind Pressure

EDITOR: The report of the Structural Divisions Subcommittee on Wind Bracing deserves careful attention. For slender buildings more than 500 ft. high, the wind loading assumptions may often be a major factor in their safety, and not a nominal one as is often the case with lower and more massive buildings. Aside from the loss of life and property in the individual building, an enormous loss in rental value of all other high buildings would result from even the partial failure of a major skyscraper. If wind loading is to be included in a building code, with a view to protection of the public and investments, it must specify excessive loadings to cover the worst possible case or else the matter must be left as a major problem for a responsible designer. A relatively inexpensive study on his part would enable him to specify adequate, but not unnecessarily excessive, loadings.

Consider the problem of including wind loading in a code. What maximum wind velocities are to be expected? The basic experimental data come in terms of average velocity for 5 min. A glance at the data shows a wide variation in maximum recorded wind velocities for different cities. In addition, if maximum wind velocities are treated by probability methods in somewhat the same way that maximum floods are treated in estimating spillway capacities for a dam, and if the data for any one locality are plotted on frequency paper, it is possible a still wider variation will be found, but it is thought that the data for one locality will be reasonably consistent. Thus treated, an 80-mile wind at Victoria, B.C., is as probable as a 60-mile wind at Vancouver, B.C. The difference between Chicago and New York might be found to be equally great.

It seems reasonable that, before specifying loadings in a given case, an investigation of the maximum probable wind velocity should be made, and that, for design, a wind such as might occur once in 5,000 years, rather than the maximum wind on record, should be chosen as a criterion. Aside from wind loads, possible earthquakes should also be kept in mind. It is generally agreed that over a period of years any part of our country may be subjected to a major earthquake, and adequate wind bracing is the only insurance on this score.

After the maximum probable velocity for 5 min. at the station of record has been fixed, an estimate must be made of the maximum instantaneous velocity. The data for this are fragmentary and, in choosing a conversion factor, the possibility of synchronism of gusts should not be lost sight of. From my own experience in measuring wind velocities on a 500-ft. radio tower, such synchronism seems by no means improbable, particularly when the vibration period is relatively long.

What loads do winds of a given velocity cause? In view of the present knowledge of aerodynamics, it seems inexcusable to use a given conversion factor regardless of the direction of the wind and the shape of the structure. With a variation of at least 300 per cent in such a factor, depending on the structure, it would seem hopeless to incorporate such variation in a code. On the other hand, the determination of the coefficient for an individual building in a test tunnel is a simple and inexpensive matter.

It is assumed that the subcommittee's recommendation of a 30-lb. loading at 1,000 ft. was made on the basis of much study and on data not published with the report. However, considering the lack of data on velocities at high elevations, the short time such structures have been built, and the conservative practice that has been followed in specifying wind loading for lower structures of far less exposure, it would appear that the proposed loading at 1,000 ft. is by no means generally conservative. As has been pointed out, it is believed that it were better, for important structures, that provision should be made for deciding each case on its merits.

S. P. WING, M. Am. Soc. C.E.
Civil Engineer, Bureau of Reclamation

Denver, Colo.
June 8, 1931

Variation in Velocities

EDITOR: There is one point on which I should like to add to the report of the Structural Division's subcommittee, published in the March issue. Reference to tables of wind velocities, as reported by the U.S. Weather Bureau and the Meteorological Department of the Dominion of Canada, discloses a very wide range in recorded velocities, which is, of course, to be expected. In our handbook on "Transmission Towers," there are reports of the United States and Canada for the years 1896 to 1922, inclusive.

This period of time is sufficiently long so that it would seem that the records of it would have had a certain degree of weight in the conclusions of the subcommittee. The greatest probable velocity varies, for the 73 stations reported, from 37 to 100 miles an hour, and we feel that this fact might well be considered by the subcommittee. A clause might be added recommending an additional amount in all localities where the probable greatest velocity exceeded, say, 70 miles an hour. By probable greatest velocity I mean, of course, the probable greatest actual velocity.

What this additional force should be—whether some arbitrary figure such as 10 lb. per sq. ft.—one hesitates to say. Possibly it might be pressure as fixed by the first recommendation, multiplied by a fraction whose numerator is the square of the probable greatest actual velocity and whose denominator is the square of 70.

C. M. Goodrich, M. Am. Soc. C.E.
Chief Engineer,
The Canadian Bridge Co., Ltd.

Walkerville, Ont.
May 3, 1931

Designing Rigid Wind Bents and Hinged Columns

Dear Sir: Little progress seems to have been made recently in the design of wind bracing for tall buildings, and the recommendations of the Structural Division's subcommittee, published in the March issue, are of special interest because they call attention to the inadequacies of our present knowledge of the subject. The range in variation of the possible wind pressure, the intricate structural design often required by architectural layouts, and the indeterminate nature of the rectangular framed bents, make anything but an empirical solution an impossibility.

However, in designing wind bracing, a question has always presented itself to my mind—namely, why are the rectangular bents in figuring the wind stresses considered as rigidly connected, while, for the vertical loads, the girders are considered as hinged at the columns? The wind loads in tall buildings require rigid connections between the floor beams and the columns. The subcommittee's eighth recommendation calls especially for deep rather than shallow bracing wherever possible. These rigid connections undoubtedly fix the ends of the girders somewhat, making them more or less continuous, and tending to throw some of the girder loads into the columns—especially in the case of exterior columns and for unequal loadings. To be theoretically correct, the bents should be figured on the principle of a rigid frame for both the vertical and horizontal loadings.

It would be interesting to know just how these loadings are actually divided in buildings of this character, which, of course, could only be ascertained by actual tests. It seems to me, however, that any analysis of the stresses due to the vertical loads should be carried out on the same basis as for the horizontal loads or, at least, that some allowance should be made for continuity. The stresses thrown into the columns and the actual distribution of stress throughout the girders due to connections of this character should not be ignored as secondary stresses. If these connections do not warrant a reduction in the size of the girders, with a possible increase in the column sizes, the method of allowing a maximum combined stress of three-quarters of the elastic limit should dictate an approximately correct solution of the problem.

Any exact valuation of the stresses in a structure of this type is, of course, impracticable, but a rational empirical method can certainly be devised that will be both safe and economical, and it is hoped that the subcommittee will direct its efforts in this direction.

Sheldon A. Keast, Assoc. M. Am. Soc. C.E.
Consulting Engineer

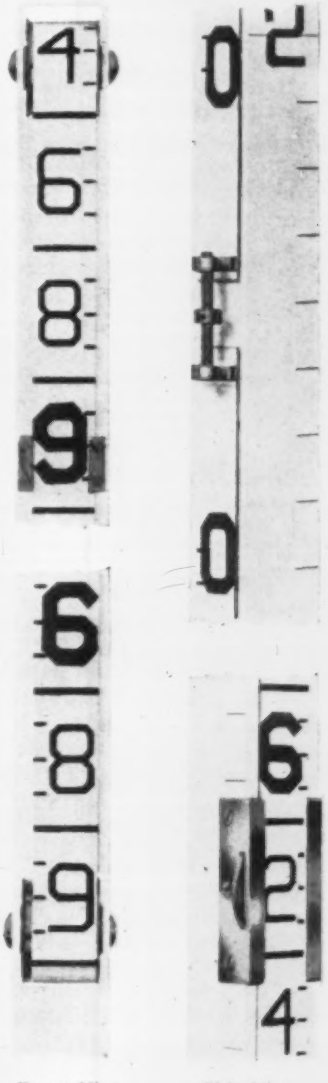
Philadelphia, Pa.
May 22, 1931

Self-Reading Tape Leveling Rod for Special Conditions

Editor: The description by Mr. Morley, in the April issue, of a universal leveling rod, calls to mind that of the Gurley Self-Reading Leveling Rod which was last illustrated and described in our *Rod Bulletin*, published in 1917. A rod somewhat similar to that shown in Fig. 1 has also been made by the Lenker Manufacturing Company, Sunbury, Pa., under the name of a "self-computing rod."

It is like many types of special rods which all rod manufacturers are called upon to make. Every engineer feels that, as a part of his profession, he is qualified to design either a stadia or a leveling rod. We have hundreds of designs of leveling rods, which have been submitted to us from time to time and have enabled particular designers to do better work or to take readings at longer distances. The value of these designs lies in the fact that they have been developed by one engineer to meet certain individual conditions. Unless these conditions are duplicated many times, however, their application is limited, and the demand for such a design is not sufficient to warrant a manufacturer's developing them.

In the design of all surveying and engineering equipment, average conditions must be studied and the instruments and equipment made to meet these conditions. The special cases are then taken care of by equipment specially designed for that particular purpose.



Front View Side View
Self-Reading
Tape Leveling Rod

However, it is a healthy sign when engineers are interested in trying to better their equipment. Many factors connected with instrument design prove the old adage, "There is nothing new under the sun." Ideas, which are perfectly logical from a manufacturer's standpoint, are often neglected because the engineer cannot be convinced of their usefulness. Sometimes, however, they are later rediscovered and brought to light, and it is possible that Mr. Morley's article will do something of that nature.

L. C. Higbee
Advertising Manager,
W. and L. E. Gurley

Troy, New York
May 4, 1931

The Problem of the Atchafalaya

SIR: I have read with a great deal of interest the paper by Mr. Purdon in the February issue. The characterization of the Atchafalaya as a "unique" stream is very apt, as engineers have puzzled over this stream, river, bayou, or bog, as we may be pleased to call it, in an attempt to frame a reasonable theory for its origin.

As plausible a theory as any is that, at some time in the remote past, a very great flood in the Mississippi overtopped its west bank at, or near, "Old River," and loosed a mighty wave which, proceeding by the shortest route to the Gulf, carved out the enigma known as the Atchafalaya. All that can be said of this theory is that it is possible.

The trouble at Pier No. 4 is an instructive illustration of the hazard involved in cutting even the toe of an old established slope. Doubtless the slide in the bank opposite this pier was caused by the excavation for the pier, which disturbed the equilibrium in the slope. This slide caused the pier to act as a retaining wall. However, since the pier was not designed as such, the resultant heavy pressure on the outside piles was sufficient to cause the indicated tilt.

I feel that Mr. Purdon readily diagnosed the situation and applied an effective remedy.

J. M. JOHNSON, M. Am. Soc. C.E.
Consulting Engineer

Louisville, Ky.
May 28, 1931

Pressure in Gravity Dams

EDITOR: It seems to me that Mr. Savage and Mr. Houk have, in their paper on tests on arch dams, in the May issue, overlooked the exceedingly important fact of under-pressure. It will doubtless be said that since an arch dam is not a so-called gravity dam, it does not depend for its stability on its weight. However, if it can be shown that there are forces not duplicated in the model test, which may be exerted against the stability of the arch itself, the real strength of the test dam is not discovered by the test.

In the tests, the bag of water or mercury is confined to the surface on the upstream area of the dam only. These tests are useful as determining the stresses in the arch due to water pressure. Inquiry must be made, however, concerning the pressure of water that may work underneath the dam, as this pressure is not duplicated in the test.

In Fig. 2, the dimensions of the dam are such that the pressure of water in a joint at the base may exceed the weight. In Fig. 4, the upward pressure could greatly exceed the weight of the arch, and there are no forces, particularly at the middle of the dam, that would offset this excess upward pressure. In gravity dams that have failed as a result of upward pressure, the upward forces were doubtless less than the weight of masonry. Being eccentrically applied, however, they tilted the dam and allowed water to enter and undermine the bed of the masonry or concrete. In an arch dam designed and tested only for horizontal forces, the forces exceeding the entire weight of the dam, in a direction to lift that weight, should not be neglected.

EDWARD GODFREY, M. Am. Soc. C.E.
Structural Engineer

Pittsburgh, Pa.
May 21, 1931

A City Plan Demands Correct Basic Information

DEAR SIR: The article by Mr. Knowles, in the March issue, is a very complete answer to the question: What is city planning and what is the engineer in public service to do about it? Many engineers, directly or indirectly connected with city planning matters, are finding themselves increasingly concerned with the answer.

Whatever city planning is or might be, the engineer engaged in public work should not stand in awe of it. He is likely to understand the various aspects of city growth and administration better than the members of any other group or profession. Naturally, he will wish to give thorough attention and study to every phase of planning, and he should, in many cases, seek advice and guidance from planning consultants. The public service engineer is usually quick to appreciate the benefits of expert counsel upon specialized technical matters. But he should realize that planning is fundamentally an engineering matter, which he and his office can, to a large extent, solve; and that, without his cooperation, any planning effort is likely to be futile.

There is nothing mysterious or difficult to understand about city planning. Speaking broadly and with no attempt at meticulous definition, its aim is the creation of a community in which the inhabitants shall have the conveniences and facilities for a healthful, happy, and profitable existence. This has always been the aim of engineers charged with public service work. However, the work needed to be done better, and we must thank the economist, the architect, and the landscape architect rather than the engineer for pointing out that need. But by far the largest chance of remedying the situation lies with the engineer, who must, in the end, secure the proper tangible results.

Perhaps the principal reason why engineers have not always taken the lead in city planning matters is their unwillingness to assume responsibility for so-called city plans which are based upon insufficient and incorrect basic information. Such plans could more properly be termed, in engineering language, "preliminary reports." A real city plan must be founded upon a solid basis of information and facts. The term "information" is here meant to include accurate large-scale maps of the territory, traffic surveys, and complete economic and social surveys of present and past conditions. A majority of the city plans, which Mr. Knowles describes as reposing "on shelves and in files, practically forgotten," are more often than not the direct result of incomplete and incorrect information, and it is to the credit of engineers that they have been rather in the minority as authors of such plans.

Engineers should strive constantly to impress upon the legislative bodies of city and county governments the necessity for this basic information for city planning. When this necessity is established, engineers will be called upon not only to secure the information, as a routine engineering matter, but also to study and evolve the consequent city plans. Thus, in a normal and natural manner, the engineering profession may be expected to assume the lead in public planning, and such plans will become plans in fact, rather than mere preliminary reports of limited or even questionable value.

R. H. RANDALL, M. Am. Soc. C.E.
President and Chief Engineer,
R. H. Randall and Company, Inc.

Toledo, Ohio
May 21, 1931

SOCIETY AFFAIRS

Official and Semi-Official

A Program for the Power Division

To Members of the Power Division:

The Division, since its organization in 1923, has witnessed remarkable technical improvement in the generation, transmission, and distribution of both steam and water power, and remarkable growth in utility company corporate structures.

Meanwhile—perhaps caused by this rapid physical and corporate development—a tendency to question and criticize the electric power industry has pervaded groups of citizens in many states and in congressional halls. These groups may be the forerunners of beneficial economic readjustment; or, on the other hand, without competent knowledge of costs of delivering power to domestic consumers, they may be driven blindly to argue for governmental operation of all electric power.

As a Division of the American Society of Civil Engineers, we deem it our duty to be non-partisan, and yet boldly to consider for the public good the broad principles involved in electric power, and other economic questions.

Your executive committee has given thought to political and economic developments. It has put increasing emphasis at Division meetings upon papers of a broad educational type with decreasing emphasis upon mere descriptions of accomplished engineering projects. Thus, in January 1930, we presented "State Supervision of the Design and Construction of Dams" (in PROCEEDINGS for March 1930), and in January 1931, "Natural Gas for Steam Power—Fuel Oil, Coal, and Gas Evaluated" (in CIVIL ENGINEERING for March 1931). A committee of the Division is carrying on studies of state supervision of dams with a view to salutary standardization of legislation.

We now bespeak your thoughtful consideration and contribution along the line of the following subjects, which are particularly appropriate for initiation by our Division:

1. Public ownership of utilities in its economic and political philosophies from a fundamental standpoint; a comprehensive study of the effect of widespread public ownership upon our American economic and political structures. Such a discussion should be devoid of local and immaterial or partisan argument, which has frequently been permitted to befog the prime issue.
2. Federal supervision of power in its various aspects with consideration of the functions of the Federal Power Commission, in respect to supervision of public utility holding companies, the economics, from the public's point of view, of overlapping and interlocking territories of rival power companies.
3. Public education with respect to the relatively low cost of steam power as compared with water power, and the economic necessity of coordination of these two main power sources.
4. A comprehensive study of the power resources of the Nation and their relation to the economic development of various sections of the country.
5. Coordination of flood control, power, irrigation, and navigation. This would supplement studies of the United States Army Engineers during the past three years, and studies by other agencies in California.
6. Engineering education, with a view to complementing technical training with well rounded business, economic, and even cultural matters, all of which better prepare a man for engineering and management work in its larger phases.

In addition to these subjects, the executive committee invites discussion of other general subjects; and, of course, we want contributions of analytical studies, and descriptions of notable power projects.

As members of our great Society we have an obligation to share useful ideas with others within and without the Society.

Executive Committee of the Power Division

Charles M. Allen John C. Stevens
Nathan C. Grover P. F. Kruse, *Secretary*
Leroy F. Harza Lynne J. Bevan, *Chairman*

June [illegible] 1931

En Route for Tacoma

Many and varied plans for the entertainment of visitors at the Tacoma Convention, July 8 through 11, have long since been matured. A number of members have made definite arrangements to be present, and as this issue of CIVIL ENGINEERING goes to press, early starters for the special trip under Society auspices are already getting under way.

An enthusiastic group of members and guests will meet at Chicago or farther west for a joint trip through Glacier National Park and then on to Rainier National Park, prior to attending the Convention itself. The setting for this trip and the favorable circumstances under which it will be carried out provide an unusual opportunity, to which those in the party are looking forward with justifiable anticipation.

It is hoped that more definite accounts of this trip and of the general features of the meeting itself will be available for the August issue. In the meantime, also, an abstract of all the technical papers will be in preparation for presentation to the membership as a whole in the September issue. The preliminary estimates of those in a position to judge are unanimous that the Sixty-first Annual Convention will set an unusually high standard in its excellence and attractiveness.

Information for Society Authors

A pamphlet just issued by the Society is entitled, "General Information on Society Publications and Preparation of Manuscript for PROCEEDINGS." This is a revised edition of a similar publication printed two years ago and since exhausted by distribution to various authors of articles for Society use.

As indicated, this leaflet is of particular value to those writers who have in mind the submission of material for PROCEEDINGS. This applies either to original papers or to discussions. Over a period of a great many years, the various details of publication policy have been crystallized so that now it is possible to put in printed form, although in brief, many of the requirements.

Even though many of the details mentioned are common knowledge to most members, they will be found useful to non-members or foreign correspondents. Still other requirements are doubtless unknown to any member who has not already submitted material for publication.

Suggestions are given as to the desirable details in the preparation of manuscript. Further suggestions cover the ideal form for illustrative material and tabular matter. In addition, there are comments on the general rules formulated by the Society's Committee on Publications for the acceptance or rejection of papers. These have resulted in the policies according to which the papers are edited and printed, which are also given in condensed form. These specific details are augmented by information of general interest regarding publications, and by a number of appendixes covering forms, Greek symbols, and other helpful material.

Although this leaflet was intended primarily to assist those authors who contemplate publication in PROCEEDINGS, many of its notes are applicable also to CIVIL ENGINEERING. Any such contributors, whether members or non-members, will be gladly furnished with a copy on request.

Another Milestone

Those members who follow the growth in Society membership from month to month will be interested to note that since the last issue went to press the number has reached and exceeded the 15,000 mark. To be exact, this interesting event took place on June 5. The previous similar occurrence, that of reaching the 14,000 mark, was noted in Part II of PROCEEDINGS for December 1929.

Years ago there was made an intimate study of membership growth, based on conditions when the total number was about

5,000. It then appeared, by virtue of calculations by proportion, curves showing trends, and the theory of saturation, that the membership would never reach 10,000. No one today makes such prognostications as to the future. What the limit of membership may be is hard to guess. More probably, there never will be a limit, but instead the Society will continue to grow gradually but consistently as long as it exists.

Coincident with the growth of the Society, it is interesting to note the growth in subscriptions to CIVIL ENGINEERING from outside the ranks of the Society. This item also reached an interesting stage during the month, when the four-hundredth subscription came in on June 5. Of this total, about 100 are foreign. By coincidence, the one numbered 400 came from Cape Colony, South Africa.

Assistance in Chinese Research Work

An appeal for assistance in carrying out engineering research work in China has recently been brought to the attention of the Society. It comes from the Chiao-Tung University Research Institute at Shanghai, China, in a letter from Chemiu J. Ku, Secretary of the Institute, addressed to H. E. Wessman, Assoc. M. Am. Soc. C.E., who for some time was professor at the university. Mr. Ku remarks:

"At present, we attempt to carry out our program especially concerning material testing and chemical research, but as we are just starting, we feel the need of guidance in planning and executing our work. Whenever you happen to know of any American professor or technical man experienced in such researches touring China, we wish that you would urge him to visit us for two or three weeks or even a few days for the above purpose. We are prepared to pay him a nominal honorarium, if necessary."

This request may well appeal to any American research engineer whose travels carry him within reach of Shanghai.

Proceedings and Transactions Summer Schedule

In the intervening summer period, when PROCEEDINGS pauses, so to speak, in its regular steady flow from the presses, another activity takes its place—namely, the preparation of the annual volume of TRANSACTIONS. As is well known, this book contains the papers that have appeared in PROCEEDINGS during the year now ending.

In PROCEEDINGS, each paper has passed the critical review of the membership, it is attacked, applauded, approved, defended, corrected, amplified, condemned, or accepted. In TRANSACTIONS all necessary corrections are made, discussions are arranged in logical order following the papers to which they refer, and two comprehensive cross indexes are provided for convenience in reference. At the end, a section is devoted to the memoirs of deceased members.

Added to the regular TRANSACTIONS published in 1905, six additional volumes were issued containing papers presented at the International Engineering Congress at St. Louis, during October 1904. These were Vols. 54 A to 54 F, inclusive. Thus, over a period of practically 60 years, 100 volumes of TRANSACTIONS have appeared, containing an imposing number of papers that have helped to make history in an engineering age. Figuratively, they have served as lighthouses, guiding the explorations of succeeding generations of civil engineers in the endless search for new ideas.

It seems reasonable to predict that several of the papers now awaiting appearance in Vol. 95 of TRANSACTIONS will take their place in line, cautioning the trained and discerning civil engineer to steer starboard or port, stop, turn about, or go full speed ahead.

An unusually-large number of engineers with national and international reputations were caught in this year's harvest of the grim reaper. True to a primary characteristic of successful men, they remained actively interested in the larger technical affairs of their profession to the end. This is sharply attested by the evidence in Vol. 95 of TRANSACTIONS, which contains the last contributions of several members whose memoirs appear between the covers of the same book. The section allotted to memoirs in Vol. 95 will prove an invaluable addition to engineering biography.

The new volume is scheduled to appear in one of the autumn months, as usual. In paper covers it is distributed free to all members; bound in cloth, there is a very nominal surcharge of $1; and for half morocco the extra charge is $2.

New Division Looks Ahead

Definite developments in its field are receiving the attention of the recently formed Engineering-Economics and Finance Division. These have been outlined in a letter distributed under date of May 27 by the Executive Committee of that Division to all those who have signified their desire to be numbered among its members.

One of the important studies under this new Division is that related to the standardization of waterway clearances, as already noted in the June issue. Past-President J. F. Coleman is acting as chairman of a committee which is proceeding with this particular study.

Many other suggestions have been submitted to the Division regarding particular lines of effort which it may well follow. Among those suggested are the following:

1. A study of valuation procedure and principles, for the formulation of approved procedure and principles.
2. Standardization of depreciation practice, including the obsolescence factor.
3. Codification of the principles underlying financial set-ups and underwriting requirements as affecting the development of engineering projects.
4. Basic requirements in engineering investigations and reports.
5. Principles of alternate plans, comparative costs, and economic selection as a preliminary to final design.
6. Collection, analysis, and codification of engineers' professional agreements with clients, as a basis for recommended principles or standardized forms based on the best practice and proven experience.
7. Development of a library review or index providing: (*a*) existing bibliography; and (*b*) current literature and new works, all relating to the economics or business phases of engineering.
8. Economics of construction plant, cost estimates, and work schedules.
9. Development of educational curricula on engineering economics.

These proposed activities of the Division are an indication of the success which is bound to come from the intimate study of such worthwhile material. The Division is fortunate, not only in its leadership but in the broad vision of its possibilities. Every member of the Society will follow its efforts with increasing interest.

Appointments of Society Representatives

ROBERT RIDGWAY, Past-President Am. Soc. C.E., C. W. HUDSON, former Director Am. Soc. C.E., and J. P. H. PERRY, M. Am. Soc. C.E., have been reappointed to the 1931 Committee on Columbia Scholarship, which is sponsored by the Society.

THEODORE A. LEISEN, M. Am. Soc. C.E., has accepted an appointment as a member of the 1931 Committee on Student Chapters, for the four-year term expiring January 1935.

CHARLES J. TILDEN, M. Am. Soc. C.E., has been appointed one of the representatives of the Society on the Division of Engineering and Industrial Research of the National Research Council.

HARRY F. FERGUSON, Assoc. M. Am. Soc. C.E., has accepted an appointment as a member of the 1931 Committee on Engineering Education, for the four-year term expiring January 1935.

DANIEL W. MEAD and EDWARD FRANCIS HAAS, Members Am. Soc. C.E., have been appointed to represent the Society at the anniversary meeting of the Verein deutscher Ingenieure in Cologne on June 28, 1931.

ROBERT ISHAM RANDOLPH, M. Am. Soc. C.E., Vice-President of the Randolph-Perkins Company, has been appointed a representative of the Society on the Washington Award Committee, to fill the vacancy caused by the expiration of Warren R. Robert's term of office.

DONALD M. BAKER, Chairman, RAYMOND A. HILL, CHARLES H. LEE, J. B. LIPPINCOTT, and F. H. NEWELL, Members Am. Soc. C.E., have accepted appointments as members on the Society's Committee on Weather Data.

Administrative Board Meeting of American Engineering Council

As Reported by Council

The Society was represented at the Administrative Board meeting of American Engineering Council, held May 15 and 16, in Washington, D.C., by H. S. Crocker, A. J. Dyer, Frank M. Gunby, and L. L. Calvert. Other members of the Society who attended, representing regional districts, were J. S. Dodds, Edgar K. Ruth, and P. L. Brockway.

Temple Suggestion Approved

The Administrative Board gave consideration to a proposal embodied in a letter dated April 28, 1931, from Dr. H. W. Temple, Congressman from Pennsylvania and father of the Temple Act (authorizing the completion of the standard topographic map of the United States in 20 years) to the Acting Director of the U.S. Geological Survey, Dr. W. C. Mendenhall. In this communication, Dr. Temple, after reciting the legislative history of the effort to secure a complete topographic map of the United States, proposed that the wording in the forthcoming Interior Department appropriation bill be made to read as follows:

> For topographic surveys in the various states of the United States, authorized by Public Law No. 498, Sixty-eighth Congress, approved February 27, 1925, $780,000; of which amount, $360,000 may be expended for personal service in the District of Columbia: Provided, that $480,000 of this amount shall be divided equally among the several states: Provided further, that when the topographic mapping of a state is completed, its share shall be available for expenditure in that state for the revision, or resurvey, if necessary, of the cultural features of the existing topographic maps: Provided further, that no part of this appropriation shall be expended in cooperation with the states or municipalities except upon the basis of the state or municipality bearing all of the expense incident thereto in excess of such amount as is necessary for the Geological Survey to perform its share of standard topographic surveys, such share of the Geological Survey in no case exceeding 50 per centum of the cost of the survey: Provided further, that $300,000 of this amount shall be available only for such cooperation with states or municipalities.

After careful consideration, the following resolution was adopted by the Board:

> *Resolved*, That American Engineering Council reiterate its endorsement of the Temple Act, Public Law No. 498, Sixty-eighth Congress, February 27, 1925, which provided for the completion of a standard topographic map of the United States in 20 years;
>
> *Be it further resolved*, That the Executive Secretary be authorized to present to the Director of the Bureau of the Budget and the appropriate committees of the forthcoming Congress, all pertinent facts at his disposal which would warrant the securing of:
>
> *a*) Sufficient appropriations to carry out the intent of the Temple Act,
>
> *b*) The removal of restrictive clauses in the appropriation bills which hinder or defeat the intent of the original Temple Act.
>
> *Be it further resolved*, That the wording of the Interior Department Appropriation Bill for 1932–1933, as proposed by Congressman H. W. Temple in his letter of April 28, 1931, is hereby approved.

Uniform Government Contracts

The subject of uniform contracts has long received the attention of American Engineering Council, and it has continuously supported in principle the legislation embodied in H.R. 5568 of the Seventy-first Congress. The Administrative Board voted to reaffirm the position of Council of support of this bill in principle and to use its influence to have Section 9 provide that the final authority with respect to liquidated damages rest with the head of the department making the contract. Because of the great importance of this legislation, all those who do business with the Government through contracts are interested in securing the enactment of this legislation during the next session of Congress.

This is a technical subject, and because engineers are in the habit of dealing with technical details, it is believed that, if public opinion is to be awakened concerning its importance, the engineering profession should undertake this task.

Unemployment Reserves and Old Age Pensions

The Public Affairs Committee gave lengthy consideration to these timely topics, and the discussion concerning them was carried over into the meeting of the Administrative Board. The following report, submitted by a subcommittee of the Public Affairs Committee, was adopted:

To the Administrative Board:

> It is recognized by the Public Affairs Committee that forces are at work to accomplish legislation, state and national, in connection with unemployment. This activity, we feel, should be brought to the attention of Council's Committee on Balancing the Forces of Consumption, Production and Distribution. The Public Affairs Committee therefore recommends the submission of the following suggestions to the above committee:
>
> 1. Outline of the problem
>
> The consideration of the problem may be divided into two parts:
>
> *a*) That part for which it is hoped a permanent solution will be found. It is more important that the solution be sound than that it be arrived at quickly.
>
> *b*) That part involving a separate problem which has to do with clarifying the immediate situation engendered by the present depression, with its resultant unemployment. Opportunist legislation, most of which is under the influence of emotion due to the depression, is being promoted all over the country.
>
> Your committee recognizes the desirability of working for a permanent and constructive solution of this problem, and believes that industry within itself should actively continue its attack on this problem. Through appropriate publicity the public should be continuously informed of the progress in this direction.
>
> Your committee deplores any attempt to do by law those things which industry can much better do for itself. Particularly do we warn against all measures which, while ostensibly providing insurance, would really bring about the dole.
>
> 2. Action
>
> *a*) It is recommended that the Committee on Relation of Production, Distribution, and Consumption be requested to exert all possible effort toward the development of a lasting solution.
>
> *b*) That Council, through its Public Affairs Committee, take immediate steps to enlist our member societies in a constructive program of study and action aiming to preserve the essential laws and principles under which our people in the past have achieved unparalleled prosperity, and to counteract doctrines that might produce results adverse to the national well-being.

Engineers' Water Power Policy Committee

Upon the recommendation of the Executive Committee, the Administrative Board authorized the appointment of an Engineers' Water Power Policy Committee, which would have the following functions:

1. To consider and report on national legislation involving questions of power.
2. From time to time, to advise with the Federal Power Commission.
3. To study and report upon the status of national and state water power policies.

The personnel of the committee is now receiving consideration.

Recanvass of Question of Registration of Engineers

Since its organization, Council has continually given attention to the question of registration of engineers. Some of its member organizations are now of the opinion that there has probably been a change of attitude toward this question by member organizations of Council, and at the May meeting of the Administrative Board, it was voted that Council request from each of its member organizations an official expression of its attitude on the subject of registration of engineers.

Technological Employment

The Executive Secretary of American Engineering Council was authorized to serve on the Committee of Technological Employment appointed by Secretary of Labor Doak. This is an official committee of the Department of Labor.

Committee on Earth and Foundations Reports

Studies of soils and subsurface structures have been actively prosecuted by the Society's Committee on Earth and Foundations. The Society has had the financial cooperation of the Engineering Foundation in its support of this committee, of which Lazarus White, M. Am. Soc. C.E., is chairman. A recent report emphasizes some of the lines along which efforts are being made and in which a promise of success is giving encouragement.

Methods of taking and testing "undisturbed" samples of all kinds of alluvial deposits are being developed; also, results are being interpreted so as to predict both rate and total of settlement of structures. Tests are being made near Boston and on the Pacific Coast. Proper use and spacing of piles and the behavior of earth beneath spread footings are being investigated.

Still other studies are being conducted in Vienna, to determine for a large area the distribution of pressure on yielding soil. The committee's collaborator there is also keeping accurate records of behavior of buildings erected throughout Europe on soft strata.

Still another field of effort involves microscopic investigations. These are being made of certain clays in search of an explanation of their behavior under foundations.

Dollars and safety, it is pointed out, can be conserved for private and public owners of structures by obtaining more and better knowledge than now exists of the many kinds of material which constitute the outer part of the earth's crust. Cost, feasibility, and security of foundations, excavations, and embankments of all kinds are affected.

Student Prize Winners

An appropriate and fitting reward for scholastic duties well done is given yearly by a number of Local Sections to certain members of the graduating classes of nearby universities and colleges. At the time of announcement, these awards are merely honors. Eventually, however, they have a more material aspect, inasmuch as, with the cooperation of the prize winner, he may be permitted to join the Society as a Junior and have his dues for the first year paid, all with the compliments of the Local Section.

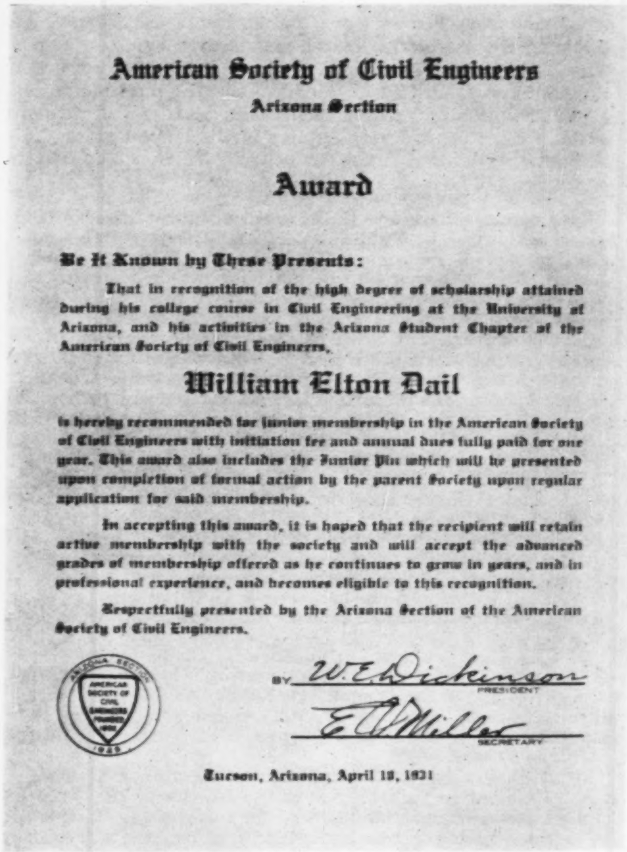
In reference to the winners of these prizes for 1931, such explanations are necessary, inasmuch as the Board of Direction has not yet acted upon their applications for membership. However, the distinction of having won the honor is very real and deserves mention here. The following list of prize-winners is partial only. It is to be hoped that it may be rounded out by the inclusion of the remaining names as they are formally submitted:

NAME OF STUDENT	COLLEGE	LOCAL SECTION GIVING AWARD
Fred A. Houck	University of Colorado	Colorado
Milo S. Ketchum, Jr.	University of Illinois	Central Illinois
Carl H. Peterson		
J. N. Pirok		
Henry Moore Metcalf	Iowa State College	Iowa
John Paul Smouse	State University of Iowa	
Wilbur Bruce Dombart	Lewis College	Illinois
John Edward Goldberg	Northwestern University	
Ernest Gerald Hurst	Rose Polytechnic Institute	
Eldon Alfred Johnson	Armour Institute of Technology	
Virgil Harold Norford	Purdue University	
Constantine Brzobohaty Voldrich	Purdue University	
George McCaw Wood	University of Illinois	
Franklin Stewart Brown	University of Illinois	
Carl H. H. Krout	Lehigh University	Lehigh Valley
W. E. Johnson	University of Minnesota	Northwestern
Earl L. Porter		
William Noble Martin	Oklahoma State Agr. and Mech. College	Oklahoma
Paul Thurber	University of Oklahoma	
Lawrence F. Wagner	Drexel Institute	Philadelphia
Frank Woodburn Parker	Oregon State College	Portland (Ore.)
Euell Francis Philpott		
Dale Emanuel Sturmer		
Douglas Harold Burnett	University of California	San Francisco
Jack Lankenou Fingado	Stanford University	
David Lee Maulsby	University of Virginia	Virginia

News of Local Sections

ARIZONA SECTION

Approximately 75 members attended the luncheon meeting of the Arizona Section, which was held in conjunction with the University of Arizona Student Chapter, at Tucson, on April 18. Interesting talks were given by Thomas Maddock, Consulting Engineer of Phoenix; Hubert Hunter, one of the members of the Student Chapter; Emmet Marx, Consulting Engineer of Tucson; Robert H. Rupkey, Assistant Engineer, U.S.I.I.S., Albuquerque, N. Mex.; Thomas A. Stiles, Assistant Manager of the Foundation Company of New York; and by J. H. Knost, Sales Engineer of the Westinghouse Electric International Company of Tucson.



American Society of Civil Engineers
Arizona Section

Award

Be It Known by These Presents:

That in recognition of the high degree of scholarship attained during his college course in Civil Engineering at the University of Arizona, and his activities in the Arizona Student Chapter of the American Society of Civil Engineers,

William Elton Dail

is hereby recommended for junior membership in the American Society of Civil Engineers with initiation fee and annual dues fully paid for one year. This award also includes the Junior Pin which will be presented upon completion of formal action by the parent Society upon regular application for said membership.

In accepting this award, it is hoped that the recipient will retain active membership with the society and will accept the advanced grades of membership offered as he continues to grow in years, and in professional experience, and becomes eligible to this recognition.

Respectfully presented by the Arizona Section of the American Society of Civil Engineers.

BY W. E. Dickinson
PRESIDENT
E. Miller
SECRETARY

Tucson, Arizona, April 18, 1931

AWARD PRESENTED BY THE ARIZONA SECTION
To W. E. Dail of the University of Arizona Student Chapter

BUFFALO SECTION

At the annual meeting of the Buffalo Section, held on May 12, Townsend Carpenter was elected President of the Section; Nathan Sturdy, Vice-President; and Roswell Buck, Secretary and Treasurer. The coming year is expected to be an intensely interesting as well as a constructive one.

COLORADO SECTION

On May 18, the 202nd regular meeting of the Colorado Section was held in conjunction with the Student Chapter of the University of Colorado. There were 44 members and guests assembled for dinner, after which Worth Allen, Attorney for the Public Utilities Commission of Denver, gave a talk on "Public Utilities and Their Relation to the Public." A number of the students spoke on various interesting subjects.

Connecticut Section

Election of officers for the coming year took place at the annual meeting of the Connecticut Section on April 24, the results being as follows: Roscoe N. Clark, President; Charles E. Smith, Vice-President; and Joseph P. Wadhams, Secretary-Treasurer.

Detroit Section

A joint meeting of the Detroit Section and the Michigan State College Student Chapter was held on April 22 at East Lansing. Speakers on this occasion were Martin De Glopper, Deputy Commissioner of the Michigan State Highway; and C. M. Cade, Associate Professor of Civil Engineering at Michigan State College.

Seven French architects and engineers, headed by Col. James Mornet of the French Army Engineer Corps, were entertained by the Section on April 28, with a luncheon and a trip to the Detroit City Airport and to Canada by way of the tunnel-bridge loop.

On May 12, a dinner meeting of the Section was culminated by a talk on the "Economic Background of the Port of Detroit," by Joseph E. Mills, Commissioner of Public Works and a member of the Port Commission of Detroit.

District of Columbia Section

A smoker meeting of the District of Columbia Section was held on March 24, with 122 members present. The speaker of the evening, Col. S. B. Williamson, member of the Inter-Oceanic Canal Board, thoroughly covered the subject of "The Inter-Oceanic Canal Problem," using lantern slides for illustrative purposes. Colonel Williamson was introduced by Gen. Lytle Brown, Chief of Engineers, U.S. Army.

Duluth Section

Members of the Duluth Section held their regular annual meeting on May 18. Officers for the coming year were elected as follows: Gordon Butler, President; Earl Kelly, First Vice-President; Leland Clapper, Second Vice-President; John Carson, Treasurer; and William E. Hamley, Secretary.

Georgia Section

Many interesting talks were features of the May meeting of the Georgia Section, held at Columbus, Ga. Among the speakers were George N. Mitcham, City Manager of Columbus, who discussed the Columbus city plan; and W. W. Hoge, Major of the Engineers Corps at Fort Benning, who gave an excellent survey of military engineering. At the invitation of Commander-General King, the party inspected Fort Benning under the guidance of Capt. W. M. Allison, Constructing Quartermaster.

Los Angeles Section

The annual event at which the members of the Los Angeles Section entertain their ladies with a dinner dance was held June 11, in the beautiful quarters of the Elk's Club. Owing to the proverbial antipathy of engineers to the making of speeches, this form of entertainment was eliminated in favor of "the days of '49," a country store, horse racing, and a genuine turtle race, followed by dancing and cards. About 200 members and guests were present.

On May 27 the last meeting of the Sanitary Group before the summer recess was held at the Maryland Cafe. The growth of "The Ammonia Chlorine Treatment of Water" for domestic supply, for swimming pools, and for industrial waters, was described by G. T. Luippold, Manager of Wallace and Tiernan Company. In addition, J. C. Albers, City Engineer of Glendale, explained the "Recent California Sanitation Legislation;" and Walter D. Smith, Assistant Engineer in the office of the City Engineer of Los Angeles, covered the subject of "Sewage Irrigation in Southern California."

Metropolitan Section

On the evening of June 9, the Metropolitan Section held a joint meeting with the New York Section of the American Water Works Association and the American Welding Society, when a very complete discussion of the welding of cast-iron and steel pipe was presented. A paper presented by T. W. Greene, Development Welding Engineer, Linde Air Products Company, dealt with the development of the welding of cast-iron pipe, its present scope, the technic of welding, and the preparation of joints. A paper on the manufacture, characteristics, and testing of pipe made by electric resistance welding, was presented by J. S. Adelson, Chief Metallurgist, Steel Tubes, Inc., and L. B. Grindlay, Manager, Metallurgical Department, Youngstown District, Republic Steel Corporation. The technic of arc welding large-diameter pipe for water distribution, including the selection of material, the preparation of the pipe, and the testing of joints, was discussed by Vincent P. Marran, Walsh Holyoke Steam Boiler Works, Inc.

Northwestern Section

Reversing the usual custom, members of the Northwestern Section were the guests of the Student Chapter of the University of Minnesota at the annual joint meeting held on May 19. Dean J. C. Lawrence, Assistant to the President of the University and member of President Hoover's Unemployment Committee, spoke on industrial economics of the past and of the future. The meeting was unusually successful as well as thoroughly enjoyable.

Philadelphia Section

There were 149 members and guests present at the May meeting of the Philadelphia Section, which featured a Philadelphia improvements program. Following luncheon, an inspection trip was made through the municipal subway stations and to the Pennsylvania Railroad's new station site. Excellent addresses were made, after a delightful dinner, by Charles H. Stevens, Chief Engineer, Department of City Transit; John H. Neeson, Chief Engineer, Bureau of Engineering and Surveys; and Thomas P. Watson, Assistant Engineer, Philadelphia Improvements, Pennsylvania Railroad, and other well known engineers. Motion pictures and slides were used to illustrate several of the talks.

Providence (R.I.) Section

Members of the Providence Section convened for their annual meeting on May 26. The following were elected officers for the coming year: James L. Murray, Chairman; Frederick C. Williams, Vice-Chairman; and William R. Benford, Secretary-Treasurer. An inspection trip was made during the afternoon to the new sewage disposal plant of the City of Providence, and Gen. S. Frank Nolan addressed the gathering in the evening on the features of the plant.

Seattle Section

A meeting of the Seattle Section was held in conjunction with the University of Washington Student Chapter on May 18. Interesting and instructive talks were presented by some of the engineering students on research work they had been doing on various subjects.

St. Louis Section

The regularly monthly meeting of the St. Louis Section was held on April 27. An interesting description of the operation of the Sperry rail-detector car and development of the apparatus used, was given by C. W. Gennett, Vice-President of the Sperry Products Company. The lecture was illustrated with lantern slides.

Attendance at the meeting held on May 25 numbered 40. An illustrated talk on termites was given on this occasion by Dr. Hermann von Schrenk, Chairman of the Committee on Timber.

Syracuse Section

On May 4, the Syracuse Section held its monthly meeting, at which officers for the coming year were elected. They are: Marshall B. Palmer, President; Warren A. Lyon, First Vice-President; H. N. Cole, Second Vice-President; and Earl F. O'Brien, Secretary-Treasurer.

Tacoma Section

An interesting illustrated talk on "Sidelights on Engineering Experiences in China" was presented by Harry P. Hart at the regular meeting of the Tacoma Section, held on May 11. There were 64 members and guests in attendance.

Texas Section

One of the most successful meetings ever held by the Texas Section convened at Fort Worth on May 8 and 9. There were approximately 100 members present. Interesting papers were read by a number of the members and general discussions on various timely engineering subjects took place. One of the most enjoyable features of the meeting was a trip to the Eagle Mountain Dam, a where barbecue was prepared.

Student Chapter News

BUCKNELL UNIVERSITY STUDENT CHAPTER

Meetings of the Bucknell University Student Chapter were held twice each month during the year. These were well attended by a large percentage of the members. At a recent meeting, C. L. Leonard, one of the students, gave an interesting talk on his impressions of the Empire State Building. Programs for these occasions have been unusually well planned throughout the year.

CARNEGIE INSTITUTE OF TECHNOLOGY STUDENT CHAPTER

Meetings of the Carnegie Institute of Technology Student Chapter were held weekly during the semester. Interesting talks were the features of the programs and among the speakers were: P. H. Helick, Maintenance Engineer of Bridges for Allegheny County; S. M. Siesel, President of the S. M. Siesel Company; Jonathan Jones, Chief Engineer of the McClintic-Marshall Company; D. R. Brewster, Lumber Utilization Engineer of the National Lumber Manufacturers' Association; and A. M. Dudley of the Westinghouse Electric and Manufacturing Company.

CLARKSON COLLEGE OF TECHNOLOGY STUDENT CHAPTER

During the past year the activities of the Clarkson College of Technology Student Chapter consisted of seven regular meetings and a banquet. Among those who addressed the meetings were Professor Van Housen, of the State Normal School, and Dr. Kennedy, of the Business Administration Department at Clarkson.

Officers for the coming year are as follows: F. Rundle, President; W. D. Hudson, Vice-President; Walter E. Vroman, Secretary; and W. Stutski, Treasurer.

COLLEGE OF THE CITY OF NEW YORK STUDENT CHAPTER

Members of the College of the City of New York Student Chapter met regularly during the past year. Many well known engineers were present and spoke at these meetings, among whom were: A. G. Hayden, Chief Designing Engineer of the Westchester County Park Commission; J. C. Rathbun, Associate Professor of Civil Engineering at the college; Harvey Wiley Corbett, Chairman of the Architectural Commission of the Chicago World's Fair and one of the Associate Architects of the Rockefeller Radio City; George Paaswell, Chief Engineer of the Corson Construction Company; F. H. Gilpin, of the Texas Asphalt Company; H. P. Burrell, Chief Engineer of the McArthur Concrete Pile Corporation; and Wayne D. Heydecker, Secretary of the Regional Plan Association of New York.

DREXEL INSTITUTE STUDENT CHAPTER

Bi-monthly meetings of the Student Chapter of the Drexel Institute were enthusiastically attended during the school year. Interesting talks were given on these occasions by Maj. C. S. Jarvis, Chief Hydraulic Engineer, U. S. Army Engineers; William F. Carson, of Carson and Carson; and O. E. MacMullen, Field Engineer of the Portland Cement Association. Motion pictures were shown at one of the meetings through the courtesy of the E. I. du Pont de Nemours Company. These dealt with divers hydraulic developments and the driving of the Cascade Tunnel.

The final meeting of the school year was held on May 26, when A. G. Hayden, of the Westchester Park Commission, spoke on "Rigid Frame Bridges." There were 45 in attendance, the largest number of the year.

GEORGIA SCHOOL OF TECHNOLOGY STUDENT CHAPTER

Frequent meetings of the Georgia School of Technology Student Chapter have been held throughout the school year, and these have been exceptionally interesting as well as instructive. Among the speakers on various occasions were: J. F. Coleman, Past-President Am. Soc. C.E.; B. M. Hall, Jr., practicing engineer; and S. B. Slack, Bridge Engineer of the State Highway Department.

On May 15, a two-day inspection was organized to the water power developments of the Georgia Power Company, at Tallulah Falls, which was thoroughly enjoyed by the 20 members of the Chapter who made the trip.

GEORGE WASHINGTON UNIVERSITY STUDENT CHAPTER

Trips to the Conowingo Hydro-Electric Development and to the new Dalecarlia Filtration Plant and Pumping Station were features of two of the monthly meetings of the George Washington University Student Chapter.

Officers elected for the coming year are: Reynold Ask, President; William S. Shoemaker, Vice-President; L. Ron Hubbard, Secretary; and Ray A. Heimburger, Treasurer.

HARVARD UNIVERSITY STUDENT CHAPTER

According to the annual report of the Harvard University Student Chapter, there are 34 members of the Chapter, practically all of whom have participated eagerly in the Chapter activities. Aside from the regular meetings of the Chapter, members attended a meeting of the Boston Society of Civil Engineers held in February, which proved most interesting. On this occasion, Robert Whitten, of the Boston Traffic Commission, addressed the gathering on the subject of the proposed "Thoroughfare Plan for Boston."

IOWA STATE COLLEGE STUDENT CHAPTER

Frequent meetings of the Iowa State College Student Chapter were held during the semester, at which the following engineers were present and gave talks on pertinent subjects: Henry Penn, of the American Institute of Steel Construction; and Charles Turnipseed, of the Marsh Construction Company.

Officers for the coming year were elected at the business meeting held on April 28. They are W. B. Hershe, President; and D. A. Gannon, Secretary and Treasurer.

JOHNS HOPKINS UNIVERSITY STUDENT CHAPTER

A number of well known engineers spoke at the different meetings of the Johns Hopkins University Student Chapter throughout the year. Among them were T. F. Hubbard, Chief Engineer of the Berliner Joyce Aircraft Corporation; and Lt.-Col. W. T. Hannum, Corps of Engineers, U.S.A., District Engineer of Baltimore. Inspection trips were arranged to the Glen L. Martin Aircraft Factory in Baltimore on April 4 and, in conjunction with the Engineers Club, on April 23, to the Safe Harbor Development.

KANSAS STATE COLLEGE STUDENT CHAPTER

Unusual interest in the bi-monthly meetings of the Kansas State College Student Chapter held during the past year is shown by the attendance recorded in the annual report. A film on the "Hydro-electric Power Production in the New South" was shown on one occasion through the courtesy of the E. I. du Pont de Nemours Company. Among the various speakers at the meetings were Fred Q. Casler of the Fairchild Aerial Surveys, Inc.; and George S. Knapp, Chief Engineer of the Water Resources of Kansas.

Officers for the coming year were chosen and they are: T. D. Morgan, President; Bob Florer, Vice-President; C. N. Walters, Secretary; and M. A. Griffith, Treasurer.

MICHIGAN COLLEGE OF MINING AND TECHNOLOGY STUDENT CHAPTER

Among the informative talks given at the meetings of the Student Chapter of the Michigan College of Mining and Technology during the past semester were those by Herman Gundlach, Building Contractor, and J. W. Kelly, of the Portland Cement Association Research Laboratories.

On May 12, the first Chapter banquet was held and proved exceptionally entertaining. Talks were given by the guests of the evening, President Hotchkiss and Professor Baxter of the college, and George Banks, Assistant U.S. Engineer.

MICHIGAN STATE COLLEGE STUDENT CHAPTER

Numbers of social as well as business meetings were listed in the annual report of the Michigan State College Student Chapter. One of the students, Andrew Dempster, gave an illustrated narrative of a trip he had taken around the world, which proved an interesting feature of one of the meetings. A joint meeting and banquet, held in conjunction with the Detroit Section of the Society, in April, was well attended and of unusual interest.

MONTANA STATE COLLEGE STUDENT CHAPTER

Meetings of the Student Chapter of Montana State College were held weekly during the year, and unusually well planned talks were given by the students. Dean Carpenter of the Washington State College, and National Vice-President of the American Institute of Electrical Engineers, gave an interesting address at a meeting on April 9.

The following officers were elected for the coming year: R. E. Slattery, President; H. M. Hanson, Vice-President; and Sigurd Wenaas, Secretary-Treasurer.

University of Kentucky Student Chapter

Membership in the University of Kentucky Student Chapter numbers 44. Meetings were held weekly during the year, at which many graduates of the university and former Chapter members spoke.

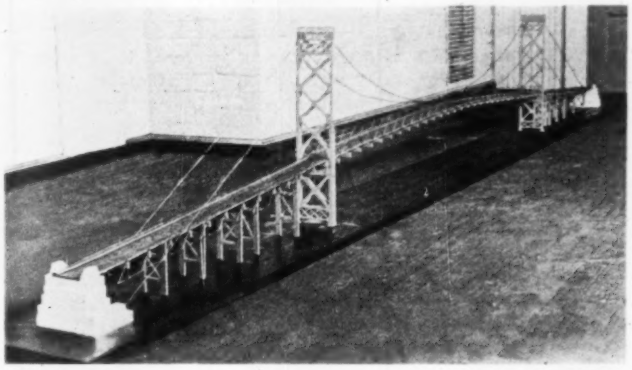
On April 22, Alexander Miller, of the American Institute of Steel Construction, spoke on the use of steel and, in addition, showed a motion picture of the erection of the Empire State Building.

University of Maine Student Chapter

At monthly meetings of the University of Maine Student Chapter held during the semester, talks were given by J. S. Crandall, of the Crandall Construction Company; F. H. Gilpin, of the Texas Company; G. M. Fair, Professor of Sanitary Engineering at Harvard University; and Professor O. C. Lyon, of the University of Maine.

University of Michigan Student Chapter

There are 34 active members of the University of Michigan Student Chapter, practically every one of whom has been a regular attendant at the meetings held during the past year. These were exceedingly interesting, well planned events and proved more than usually instructive.



Model Detroit-Windsor Bridge, Scale 1 in. = 20 ft.
Built by Seniors of the Structural Engineering Department, University of Michigan

"Engineering Open House" was held on May 8–9, by the Engineering College of the University, at which the Student Chapter sponsored the civil engineering display. One of the most interesting features was a model of the Ambassador Bridge, which connects Detroit and Windsor, Canada.

University of Nebraska Student Chapter

During the past winter the Student Chapter of the University of Nebraska has held a number of interesting meetings. On May 13, a joint meeting was held with the American Institute of Electrical Engineers and the American Society of Mechanical Engineers student chapters, at which the safety crew from the Lincoln Telephone and Telegraph Company gave a talk and demonstration.

University of New Hampshire Student Chapter

Quite a number of the 22 members of the University of New Hampshire Student Chapter gave exceptionally interesting talks at the various meetings held during the year. These were well planned, and the subjects covered included all types of engineering projects and also the more romantic aspects of the engineering field.

University of New Mexico Student Chapter

Meetings of the University of New Mexico Student Chapter were held regularly during the school year. The character of these was, for the most part, delightfully informal in spirit, and they were thoroughly enjoyed by the members of the Chapter.

University of North Dakota Student Chapter

Activities of the University of North Dakota Student Chapter during the past year consisted of bi-weekly meetings of the Chapter, at which interesting talks were given by noted engineers and, in some instances, slides and motion pictures were shown.

April 4 was "Engineers' Day," and the main exhibit of the civil engineers was the model of an airport for the City of Grand Forks.

University of Southern California Student Chapter

All of the members of the University of Southern California Student Chapter have been actively interested in its affairs and consequently the year's programs were not only enjoyable but exceedingly helpful. Talks were given by Franklin Thomas, Professor of Civil Engineering at the California Institute of Technology; R. F. Goudey, Sanitary Engineer of the Bureau of Water and Power, Los Angeles; A. F. Barnard, Consulting Engineer; H. W. Dennis, Chief Civil Engineer of the Southern California Edison Company; and Merrill Butler, Bridge Engineer, City Engineers' Department, of Los Angeles.

Practically all of the meetings of the Los Angeles Section have been attended by a representative group of the members of the Student Chapter of the University of Southern California.

University of Texas Student Chapter

Among the speakers at the bi-monthly meetings of the Student Chapter of the University of Texas were L. M. Chokla, Paving Engineer for the City of Austin; J. B. Early, Maintenance Engineer of the Texas State Highway Department; R. F. Dawson, Testing Engineer for the Bureau of Engineering Research; and B. F. Williams, State Reclamation Engineer.

E. A. McNatt and V. D. Meisenheimer, members of the Chapter, won prizes in the contest sponsored by the Associated General Contractors of the Highway Branch, Texas, for the best papers on "Contractual Relations between Engineer and Contractor."

University of Virginia Student Chapter

Meetings of the University of Virginia Student Chapter took place each month during the year and were enthusiastically attended. Through the courtesy of the Virginia Bridge and Iron Company, the Chapter was able to visit the company's shops during the latter part of May. This trip was a source of valuable information.

Officers for the coming year are: J. E. Blann, Chairman; G. D. Belote, Secretary; and J. N. Daniel, Treasurer.

University of Washington Student Chapter

During the past year, meetings of the University of Washington Student Chapter were held each month. As a special feature at one of these gatherings, Dean Tylor showed some interesting moving pictures, which included last year's field trip together with other items of local interest.

Officers for the coming year are: R. S. Stewart, President; Oliver Moreland, Vice-President; and John A. Adams, Secretary-Treasurer.

Washington University (Collimation Club) Student Chapter

Officers of the Washington University (Collimation Club) Student Chapter have been chosen for the coming year. They are: Arthur E. Biermann, President; Frank H. Seitz, Vice-President; and Richard M. Torrance, Secretary-Treasurer. Besides student speakers at the meetings, W. C. E. Becker, Construction Engineer, spoke on the Eads Bridge, and E. O. Sweetzer, Professor of Structural Engineering at the university, followed with "Testing the Eads Bridge."

The President of the Society, Francis Lee Stuart, and Secretary George T. Seabury were present at the business meeting of the Chapter, held on May 1. Both gave interesting talks.

Yale University Student Chapter

An annual report from the Yale University Student Chapter indicates that meetings held during the semester were interesting and well attended. The following engineers addressed the gatherings: Prevost Hubbard, Chemical Engineer of the Asphalt Association; Frederick H. Frankland, Director of Engineering Service, American Institute of Steel Construction; A. C. Eaton, Hydraulic Engineer; and Fred Lavis, Consulting Engineer of New York City.

Ohio Northern University Student Chapter

According to the annual report, there are 30 members of the Student Chapter of the Ohio Northern University. Meetings were held bi-monthly throughout the year, and were exceptionally interesting. Talks on various engineering topics were given by the students.

Ohio State University Student Chapter

Among the speakers at the monthly meetings of the Ohio State University Student Chapter were: J. F. Coleman, Past-President Am. Soc. C.E.; Tom Lewis, of the Mt. Vernon Bridge Company; Francis Lee Stuart, President of the Society; and Lytle Brown, Chief of Engineers, U.S. Army.

Officers chosen for the coming year are K. Woods, President; Ray Miller, Vice-President; and N. J. McMillan, Secretary and Treasurer.

Oklahoma Agricultural and Mechanical College Student Chapter

Unusually interesting meetings of the Oklahoma Agricultural College Student Chapter were held during the past year. On one occasion a moving picture, entitled "Blasting of Water Highways," was shown and proved instructive as well as interesting.

The following are the officers chosen for next year: John Scroggs, President; E. C. Warkentin, Vice-President; Dayton Williams, Secretary; and Donald Slusher, Treasurer.

Oregon State Agricultural College Student Chapter

Eight meetings of the Oregon State Agricultural College Student Chapter were held during the year. These were interestingly varied, consisting of business meetings, breakfasts, motion pictures, and, on one occasion, a smoker. Officers for the coming year are: Warren E. Gilbert, President; Elden Carter, Vice-President; and Adolph Benscheidt, Secretary-Treasurer.

Pennsylvania State College Student Chapter

Monthly meetings of the Pennsylvania State Student Chapter held during the past year offered interesting programs and were exceptionally well attended.

Officers for the coming school year are: H. J. Martin, President; C. G. Lear, Vice-President; W. J. Schooley, Secretary; and W. H. Lehmburg, Treasurer.

Polytechnic Institute of Brooklyn Student Chapter

Under the guidance of the speaker, trip, and entertainment committees, the Student Chapter of the Polytechnic Institute of Brooklyn enjoyed its regular monthly meetings during the past year. Among the speakers on some of these occasions were: Leicester Durham, Assistant Engineer of the New York City Board of Estimate and Apportionment; and T. Kennard Thomson, Chairman of the Mayor's Board for City Planning. Trips were organized to the Rockville Center Activated Sludge Treatment Plant, and to the Bronx Shaft of the Catskill Aqueduct Tunnel.

A short interesting talk by A. P. Richmond, Assistant to the Secretary of the Society, was given at an informal meeting on April 13. Officers were then elected for the coming year. They are: Isadore Moskowitz, President; Michael Imperiale, Vice-President; and Irvine Last, Secretary and Treasurer.

Rice Institute Student Chapter

Meetings of the Rice Institute Student Chapter were held frequently throughout the semester. Among the speakers present on these occasions were: R. J. Cummins, Consulting Engineer of Houston; and J. C. McVea, Municipal Improvements Engineer, also of Houston.

South Dakota State School of Mines Student Chapter

Meetings of the South Dakota State School of Mines Student Chapter, at which descriptive talks were given on varied engineering projects, were held regularly each month. Among the speakers were A. B. Hood, Engineer for the Warren Lamb Lumber Company, and H. H. Babcock, District Highway Engineer of the State Highway Department.

Stanford University Student Chapter

The Student Chapter of Stanford University held both a business and a social meeting each month throughout the entire school year. These were interesting as well as instructive. Among the speakers were H. H. Hall, Chief Engineer of the Standard Oil Company; Dexter S. Kimball, Dean of the Engineer School of Cornell University; and Shirley Baker, Consulting Engineer.

State University of Iowa Student Chapter

Meetings of the State University of Iowa Student Chapter were held each week during the past year. Interesting talks, supplemented in many instances by illustrative material, were given by well known engineers, among whom were: W. L. Abbott, Chief Engineer of the Commonwealth Edison Company of Chicago; and Mr. Barker, of the Portland Cement Association.

Union College Student Chapter

Eight meetings of the Student Chapter of Union College have been held during the school year. Among the speakers on these occasions were: S. O. Shamberger, Hydraulic Engineer of the New York Power and Light Corporation; Dr. Wiliam Bowie, Chief Engineer of the U.S. Coast and Geodetic Survey; Frank Alcott, member of the National Lumber Manufacturers' Association; L. G. Holleran, Deputy Chief Engineer of the Westchester County Park Commission; Prof. Frank P. McKibben, Consulting Engineer of the General Electric Company; and D. Dana, of The New York Port Authority.

University of California Student Chapter

Of the (approximately) 90 members of the University of California Student Chapter, 65 were regular attendants at the monthly meetings. Interesting talks were given as part of the meeting programs, and among the speakers were: George Calder, of the American Toll Bridge Company, and Fred Tibbets, Consulting Engineer of San Francisco.

Officers were chosen for the coming year as follows: Robert D. Dewell, President; Wesley Getts, Vice-President; Edward J. Reese, Secretary; and Raymond E. Gauthier, Treasurer.

University of Idaho Student Chapter

Unusually interesting meetings of the University of Idaho Student Chapter have been held during the past year, at which several motion pictures and illustrated lectures were featured. Quite recently the members attended the spring picnic, which officially and enjoyably closed the Chapter activities for this year.

Officers for the first semester of next year are as follows: Clifford Hallvik, President; Nelton Cairnes, Vice-President; and Clifford Grendahl, Secretary-Treasurer.

University of Illinois Student Chapter

Interesting programs comprised the meetings of the University of Illinois Student Chapter held during the past year. Speakers on some of these occasions were T. L. Condron and Harrison P. Eddy, consulting engineers; E. A. Hadley, Chief Engineer of the Missouri Pacific Railroad, and Montgomery B. Case, Engineer of Construction, The Port of New York Authority. Attendance at the meetings averaged 124 during the semester.

The *ILLINI A.S.C.E.*, the Chapter's publication, was brought out in May and proved entertaining as well as instructive.

University of Kansas Student Chapter

Talks and illustrated lectures given by the Chapter members were well received at the meetings of the University of Kansas Student Chapter. As a special feature, Lloyd Miller, of the Corps of Engineers, U.S. Army, was guest speaker on one occasion.

The Chapter built models of a clover-leaf highway crossing, testing of beams in the testing laboratory, and also a model of the Great Northern Tunnel through the Cascades, and displayed them at the Engineers' Exposition.

Vanderbilt University Student Chapter

Programs of exceptional interest were arranged for the meetings of the Robert H. McNeilly Student Chapter during the past school year. These consisted of talks and illustrated lectures given almost exclusively by the students. Attendance was unusually good.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for August

THE SUBJECT OF riparian ownership has so many ramifications and legal by-passes that each court action has a far reaching effect. Therefore the article on the effect of recent court decisions on water rights, to appear in next month's issue of CIVIL ENGINEERING, will have outstanding interest.

In the field of sanitary engineering, A. M. Rawn, M. Am. Soc. C.E., will describe a unique piece of design and construction just completed for the separate digestion of sludge in four-stage batteries. Digested sludge is segregated and moved forward from tank to tank by gravity. Methods of sludge heating and gas collection are other features of the new plant of the Los Angeles County Sanitation Districts.

For those interested in Mississippi River flood control—and every taxpayer of the United States is financially interested in it—J. P. Kemper, M. Am. Soc. C.E., has a new solution of this stupendous problem which does not require the purchase of great areas of floodway lands.

In the realm of soil mechanics, Charles H. Lee, M. Am. Soc. C.E., Consulting Engineer, will feature the work which engineers can do with common earth as a basic material of construction.

A number of other equally interesting, equally instructive papers on highways, irrigation and flood control, will contend for place in the August issue, from which a selection will be made with the purpose of presenting material having the widest appeal to readers.

Alloys of Iron Research

IN 1929 the Alloys of Iron Research was organized by the Engineering Foundation with the assistance of an advisory committee appointed by the American Institute of Mining and Metallurgical Engineers. With the cooperation of the American Iron and Steel Institute, several technical societies, research institutes, and governmental bureaus, and a number of leading executives in the iron and steel industry, $230,000 was subscribed to finance the work for a period of five years. The Iron Alloys Committee was appointed to assume active charge.

The purpose of the Alloys of Iron Research is threefold:

1. To review critically all research work on iron and its alloys, as reported in the technical literature of the world from 1890 to date, and to assemble the data thus collected in form convenient for reference.

2. To publish information collected by this critical review in two kinds of books: (*a*) monographs, for the scientist and research worker; and (*b*) manuals, for the technician, the executive, and the engineer in the ferrous industries and related fields.

3. To call attention in these books to errors in existing data; to define clearly the gaps now present in our knowledge of the alloys of iron, both of pure alloys and of commercial irons and steels; and to encourage and promote research for basic facts to fill these gaps.

The organization of the Alloys of Iron Research consists of an editorial staff at the Engineering Societies Building in New York, and four cooperating groups.

Editorial work was started February 1, 1930. In the ensuing 16 months, satisfactory progress has been made by the editorial office and by the cooperating groups. To date, 2,000 technical papers from 30 journals in 5 languages have been reviewed and more than 6,000 abstracts prepared, covering about 35 elements and 500 classifications. Already much valuable information has been abstracted and filed. Considering that the critical review of the literature has been going on but slightly more than a year, progress toward a definite program of publication has been noteworthy.

A Humanitarian Movement

TO AROUSE popular interest in the plan to build Hoover Dam with a minimum loss of life, the Florence Nightingale Institute of Honorables of the United States of America, of which Miss Georgia Bryton of Los Angeles is the founder, proposes to confer not less than six honorary fellowships annually during the life of this construction work. These will be given to those in actual charge, whose records show the least number of fatalities on their part of the construction. Actuated solely by humanitarian motives, the Institute will present certificates of award imprinted on parchment. The awards will be designated as "The Edward G. Sheibley Awards for the Conservation of Human Life at Boulder Dam." For a number of years Mr. Sheibley, M. Am. Soc. C.E., has been interested in industrial safety work.

COMING EVENTS

WESTWARD, HO!

SUMMER MEETING OF THE
AMERICAN SOCIETY OF CIVIL
ENGINEERS

Convenes in Tacoma, Wash.
July 8, 9, 10, 1931

INTERNATIONAL ROAD MACHINERY
EXPOSITION

Los Angeles, Calif.
July 20–26

Honorary Degrees for Members

IT SEEMS to be a sign of the times that engineers are being accorded honorary degrees at commencement time to an extent which was unknown a decade or two ago. The year 1931 is no exception to the general rule.

A number of such instances have come to notice, and without doubt there are many more that are unknown—the engineer's native modesty being what it is. From the current press the following items have been taken:

OTHMAR H. AMMANN, M. Am. Soc. C.E., Doctor of Engineering, New York University.

LYTLE BROWN, M. Am. Soc. C.E., Doctor of Engineering, Michigan College of Mining and Technology.

JAY DOWNER, M. Am. Soc. C.E., Doctor of Science, Columbia University.

LESLIE G. HOLLERAN, M. Am. Soc. C.E., Master of Science, Union College.

SAMUEL M. VAUCLAIN, M. Am. Soc. C.E., Doctor of Engineering, Worcester Polytechnic Institute.

WILLIAM B. LANDRETH, M. Am. Soc. C.E., Doctor of Science, Union College.

WILLIAM VON PHUL, M. Am. Soc. C.E., Doctor of Engineering, Tulane University.

AMBROSE SWASEY, Hon. M. Am. Soc. C.E., Doctor of Science, Brown University.

JOHN R. FREEMAN, Hon. M. Am. Soc. C.E., Doctor of Science, Yale University.

Valuable Rainfall Data

AS MENTIONED IN the May issue, the Society has made arrangements for supplying to those members who are interested, enlarged copies of an extensive table formulated by C. S. Jarvis and published originally in connection with his paper, "Rainfall Characteristics and Their Relation to Soils and Run-Off," in the January 1930 issue of PROCEEDINGS. Since the previous notice, a number of members have written to take advantage of this offer; but the response thus far has not been sufficient to justify the Society in undertaking the expense involved.

This table condenses data compiled for stations throughout the entire civilized world. It represents an immense amount of time and study and it has been accorded great honor by hydrologists and engineers wherever it has been exhibited.

For purposes of economy and to come within the limitations of printing PROCEEDINGS and TRANSACTIONS, this table had to be restricted in size. Although in this form the individual figures are legible, many members have wished that the table could be expanded for office use. As a result of this demand, the Society has made tentative provision, and will be glad to furnish sets of the entire table, capable of folding into the bound and ordinary letter-size folders, at a cost of $2.00 per set.

If there are other engineers who have as yet not ordered this material and desire to do so, they should send in their requests immediately. Work on this paper for TRANSACTIONS is progressing, and reprints of this table will not be undertaken after the present use of the material is completed. This, therefore, is the "last call" to those who wish working copies of the Jarvis Rainfall Table.

First Steam Railroad in the United States to Be Scrapped

ITS PASSENGER BUSINESS taken away by busses, and its freight by trucks, the Delaware and Hudson Railroad has requested permission of the Interstate Commerce Commission to abandon 23 miles of its line, between Carbondale and Honesdale Junction, Pa., according to newspaper reports. On this line, which was originally built in 1828 to transport "stone coal," as anthracite was then called, the first steam locomotive in the United States operated. The trial run of the "Stourbridge Lion," imported from England, was made on August 8, 1829, on wooden rails protected with rolled iron strips.

Single Court of Patent Appeals Proposed

ESTABLISHMENT of a single court of patent appeals is proposed by the American Engineering Council, in a report of its Patents Committee.

It is stated that such a court would substantially stimulate inventing, and would protect both the patentee and the public from enormous financial waste. The National Association of Manufacturers is said to have approved the proposal, which is now under advisement by various committees of patent law associations. The report states:

"Because of the peculiar nature of the patent monopoly, the present system of appeals in patent infringement suits in the United States is the most inefficient, expensive, and wasteful to be found anywhere. It is a deterrent to the production of inventions, and to the investment of capital in patents. Correction of this condition is by far the greatest need of our patent system."

A bill which provides for a single "Court of Patent Appeals" sitting at Washington and composed of a chief justice and six associate judges, has been prepared. The court is to have final jurisdiction of all appeals in patent cases from the District Courts of the United States and from the Supreme Court of the District of Columbia, both in interlocutory and final orders and decrees, jurisdiction of the United States Circuit Courts of Appeals in patent appeals being abolished. The power of the Supreme Court of the United States to order cases certified to it is extended to include the single court of patent appeals, and the right is given to that court to certify questions to the Supreme Court for instructions.

The salaries of the chief justice and the associate judges of the single court of patent appeals are set, respectively, at $14,500 for the chief justice, and $13,000 for the associate judges. These are higher than those of the Circuit Courts of Appeals. The single court of patent appeals, therefore, would be of higher rank than the United States Circuit Courts of Appeals—the next in rank to the Supreme Court of the United States. This, it is believed, would assure that a sufficient number of the best qualified judges in patent cases will be available for appointment to this court.

In order that the judges shall be specially qualified for the single court of patent appeals, the bill provides that "experience in the adjudication of a substantial number of patent cases on the Federal bench, or in the practice of patent law in the Federal courts, shall be requisite to appointment as chief justice or a judge of said court, to the end that only judges who have shown special aptitude for the adjudication or the practice of the patent law shall be appointed to said court."

For the first century of our patent system, there was a single court of patent appeals, and that was the Supreme Court of the United States. But this court became so overburdened with work that, in 1891, the appeal to the Supreme Court was taken away, and the country was divided into nine circuits, now ten, each of which was provided with a Circuit Court of Appeals, which has final jurisdiction over all patent appeals in its circuit.

Quoting further from the report: "There is no appeal to the Supreme Court. The only right is that of petitioning the Supreme Court to grant a writ of certiorari, ordering the case to be sent up to it. The Supreme Court has such an enormous volume of work that it does not take up a patent case unless there is some question of public importance, or of interpretation of law, or unless the Circuit Courts of Appeals of two circuits have decided the same question concerning the same patent in opposite ways. The expense of repeated litigations accompanying the present system makes them impossible to the individual and constitutes a burden from which even the large corporations shrink."

Testing Apparatus Shown

VISITORS to the Exhibit of Testing Apparatus and Machines, of the American Society for Testing Materials, held June 22 to 26 in Chicago, saw how small testing machines can be and nevertheless effectively determine certain data. A special hydraulic testing machine built by a leading research laboratory exerts a pull of only 60 lb. It was developed to make cross bending tests of flat springs in connection with a study of hydrogen embrittlement. The pressure in the oil chamber is so small that it is measured by a water manometer, in place of the usual test gages.

Another machine, designed for fatigue tests on specimens 0.05 in. in diameter, stands on a 4 by 10-in. base and is only 4 in. high. It weighs less than 10 lb., but has been successfully used and serves its purpose well.

Apparatus was shown which had been developed by Committee C-5 of the Society for Testing Materials in order to measure the fire resistance of wood, especially to the spread of flames. A specimen of wood is suspended in a long iron tube and a gas flame is applied. An ingenious device measures the loss of weight, and other measurements are also made. This apparatus has demonstrated that it is a reliable and quick method of measuring the property of wood to support combustion, and numerous successful tests have been made at the Forest Products Laboratory, where it was constructed.

The Edgar Marburg Lecture for the year was given by Dr. A. Nadai, who described outstanding developments regarding the "Phenomenon of Slip in Plastic Materials." To demonstrate the fundamentals of this subject, he has evolved interesting equipment by which faint traces of plastic flow can be observed and deformed surfaces of metal specimens can be photographed.

In the Bell Telephone Laboratories booth were several special testing machines, among them a fatigue machine for sheet metals, designed to test simultaneously 40 specimens of sheet metal of varying thicknesses. It is possible, by varying the deflection of the reciprocating arms, to vary the intensity of the stress. The development of this machine has increased materially the prospects of securing adequate fatigue results on non-ferrous alloys within a reasonable length of time.

Verein Deutscher Ingenieure

ABOUT THE TIME this issue is scheduled to reach the membership, that is, from June 26 to 29, a notable celebration will be taking place in Cologne, Germany. There the Verein deutscher Ingenieure will be marking the completion of 75 years of existence.

This eminent German society, which occupies a distinguished place among the technical bodies of the world, will celebrate in fitting style. Delegates from all over the world will be present to bear testimony, by their very attendance, to the esteem in which the organization is everywhere held. The Society will have the honor to be represented on this occasion by Edward F. Haas, of San Francisco, and Daniel W. Mead, of Madison, Wis.

In connection with this celebration, a tour of Europe has been arranged by the American Society of Mechanical Engineers, starting June 13 and due to return to New York August 5. This will take in the seventy-fifth anniversary celebration as one of its features. Several members of the American Society of Civil Engineers are in the party.

Reappointment of Freeman Scholar

With the expiration of the present term of the Freeman Fund Scholar, Lieut. Hans Kramer, Assoc. M. Am. Soc. C.E., it has been necessary to select his successor, as recently announced in the May issue of Civil Engineering. After full consideration, the Committee on the Freeman Fund has decided on the redesignation of Lieutenant Kramer, who will therefore continue his work and studies in Europe.

For almost a year, he has been busily occupied in intimate contacts with many of the more important hydraulic laboratory installations throughout the Old World. His monthly reports, extracts from some of which have been noted in Society publications, have given a clear insight into the many hydraulic problems now being attacked and solved throughout Europe. These reports are available at Society Headquarters for those who are interested in such developments.

Judging by his previous experiences, Lieutenant Kramer will be able to make admirable use of his remaining time in extending and rounding out his work. The Committee on the Freeman Fund consists of John R. Freeman, Walter E. Spear, and Thaddeus Merriman, Chairman.

NEWS OF ENGINEERS

John J. Ledbetter, Jr., is now Assistant Engineer of the American Section of the International Water Commission in San Benito, Tex. He was previously Assistant Engineer of the City Engineering Department of El Paso, Tex.

Frank R. Laying has been advanced from Assistant Chief Engineer to Chief Engineer of the Bessemer and Lake Erie Railroad Company, with offices at Greenville, Pa.

E. T. Schuleen, formerly associated with the Aluminum Company of America, is now with the Pennsylvania Water and Power Company at Holtwood, Pa.

Oswald Speir has resigned from the Public Works Engineering Corporation of San Francisco and is now with the Trojan Engineering Corporation, located in the same city.

A. W. Green, Jr., who has been Bridge Engineer for the Compañia Constructora Latino-Americana in San José, Costa Rica, is now a Bridge Designer with offices in Louisburg, N.C.

Harry L. Kinsel, having resigned from the position of Engineering Assistant in the Philadelphia office of the Pennsylvania Department of Health, is at present an Assistant Engineer for the Village of Mamaroneck, N.Y.

Kurt H. Siecke, formerly Assistant Engineer of the Missouri Pacific Railroad, is now a Consulting and Contracting Engineer for the United States Waterproofing Company.

Eric Bottoms has been advanced from Inspector to Junior Engineer with the Corps of Engineers, War Department, Chicago.

F. H. Frankland, who is associated with the American Institute of Steel Construction, Inc., announces the removal of the institute's offices to 200 Madison Avenue, New York.

Horace L. Wilcox has been appointed Design Draftsman at the Naval Operating Base, Norfolk, Va.

Daniel B. Ventres is now connected with the U.S. Bureau of Public Roads, Denver, Colo. He was formerly employed by the Plant Department, Navy Yard, Boston.

William L. Eager, a former Junior Highway Engineer of the U.S. Bureau of Public Roads, Denver, Colo., has recently become Construction Engineer of the Pre Cote Sales Company, Des Moines, Iowa.

John T. Eastwood, head of the Engineering Department of the Sewerage and Water Board of New Orleans, La., has retired from that position and will devote his time hereafter to consulting work of a similar character.

E. T. Collier has accepted a highway location position with the Florida State Road Department.

A. L. Hartridge, previously Vice-President and Construction Manager of the Stone and Webster Engineering Corporation, is now President and General Manager of the A. L. Hartridge Company.

Dr. Boris A. Bakhmeteff, one-time Undersecretary of State, and later Russian Ambassador to the United States, has been appointed Professor of Civil Engineering at Columbia University.

Walter D. Binger, formerly first Vice-President of the Adelson Construction and Engineering Corporation of New York, and William Ginsberg, second Vice-President of the same company, have formed a partnership for the practice of consulting engineering in New York.

C. B. Bagnall is now connected with the Union Engineering Company at Huntington Park, Calif. He was previously employed by the Concrete Engineering Company of Los Angeles.

Arthur J. Trapp, previously Construction Engineer of the Department of Water Supply, Pontiac, Mich., has begun his work as Assistant Engineer for the Superintendent of Lighthouses at South Portland, Me.

Carroll C. Winter has become associated with the Western Pacific Railroad Company at San Francisco, Calif. He was Assistant Engineer for the Martinez Benicia Bridge Company at Martinez, Calif.

Louis H. Schlom is now Secretary and Treasurer of the Weeks Construction Corporation of Houston, Texas.

Carl F. Mau, formerly County Surveyor and City Engineer of Redding, Calif., has accepted a position as member of the engineering staff of the California State Highway Commission.

Dwight Harrison, Jr., has severed his connection with Thomas King Company, Inc., and is now associated with the Perma-Bond Company of Detroit as Vice-President and Engineer.

R. J. Driscoll, heretofore with the Goulds Pumps, Inc., at Seneca Falls, N.Y., has accepted the position of Sales Engineer at their Chicago office.

Thomas C. Desmond, President of T. C. Desmond and Company, Inc., at Newburgh, N.Y., has given up his former residence and place of business in New York City, and is living at Newburgh, where in his capacity as state senator from the Orange-Sullivan County District, he is devoting practically his entire time to philanthropic and public service.

Leon S. Moisseiff, Consulting Engineer, was selected by the American Bureau of Welding to succeed the late James H. Edwards as Chairman of the Structural Steel Welding Committee.

William D. Hull has accepted a position with the State Highway Department at Atlanta, Ga.

Raymond K. Fietsam, who has been with The Indian Refining Company at Lawrenceville, Ill., has returned to the Texas Company, Port Arthur, Tex.

C. A. Latimer, formerly Chief Engineer for R. E. Hall and Company, Inc., has accepted the position of Village Engineer in the Village of Mamaroneck, N.Y.

Robert M. Feustel, Executive Vice-President of the Midland United Company, Fort Wayne, Ind., was previously President of the Indiana Service Corporation.

George G. Toler, has become Assistant Division Engineer of the Oklahoma State Highway Department, Tulsa. Formerly he was Resident Engineer for the same department, at Tulsa.

Arthur Newell Talbot, Past-President Am. Soc. C.E., Professor of Engineering Emeritus, University of Illinois, was the recipient of the Henderson Medal, presented at the Medal Day exercises of the Franklin Institute.

John A. Clark has been appointed Sanitary Engineer in charge of Division 3 of the Alameda County Mosquito Abatement District, with headquarters in Hayward, Calif.

Roger B. McWhorter, Principal Engineer of the Great Lakes Division of the United States Engineer Department, has been appointed Chief Engineer of the Federal Power Commission.

Frank D. Chase, of Chicago, was elected President of the Western Society of Engineers at its annual meeting held in Chicago on May 28.

John W. Alvord and Charles F. Loweth have been the recipients of honorary memberships conferred upon them by the Western Society of Engineers.

Herbert V. Clotts has been appointed Assistant Director of Irrigation in the Indian Service, U.S. Department of the Interior, with headquarters at Los Angeles where he will be in charge of the Field Office of the Service.

Herbert DePue has accepted the position of Junior Civil Engineer in the Department of Commerce, Airways Division, Washington, D.C.

R. E. J. Summers has resigned as Vice-President and Contact Manager of the H. K. Ferguson Company to become President of the Summers Engineers and Constructors, Inc., with offices in Cleveland, Ohio.

Seisuke Takahashi has been transferred from Sales Manager and Director of the Steel Company of Japan to Director of the Japan Steel Products Co., Ltd., in Tokio.

P. J. Haugh, who was previously Assistant Engineer in the Office of Public Works, Athy, County of Kildare, Ireland, is now Assistant County Surveyor to the Offaly County Council in Ireland.

Onslow S. Robinson has become connected with the W. C. Ghormley Company as Engineer on the Tennessee River Bridge near Paducah, Ky. He was formerly associated with E. D. Robinson in Chilmark, Mass.

George G. Earl and Ralph Earl have opened offices in New Orleans under the name of the Earl Engineering Company. George Earl was previously General Superintendant and Chief Engineer of the Sewerage and Water Board of New Orleans, La.

Edw. L. Taylor, formerly associated with the Connecticut Savings Bank in New Haven, has recently been appointed a member of the Commission of Public Utilities of the State of Connecticut, with headquarters in Hartford.

Samuel R. Young, formerly Assistant Chief Engineer of the Atlanta and West Point Railroad Company, the Western Railway of Alabama, and the Georgia Railroad, has been appointed Chief Engineer of these railroads.

Gilbert H. Friend is now a civil engineer in the Quartermaster Corps, U.S. Army, Washington, D.C. He was previously Manager of the Silica Tile Company.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From May 9 to June 6, 1931

ADDITIONS TO MEMBERSHIP

Anderson, William Wayne (Assoc. M. '31), Div. Engr., State Highway Dept., 535 Wadsworth Rd., Medina, Ohio.

Andrews, Marshall John Clarke (M. '31), Chf. of Parties, Portland Canal Power Co., Ambassador Hotel, 8th and Union, Seattle, Wash.

Appel, Emil Ernest (M. '31), Asst. Engr., Gulf Refining Co., 1726 Koppers Bldg., Pittsburgh, Pa.

Barnes, Robert Leland (Assoc. M. '31), Asst. Bridge Constr. Engr., State Highway Comm., Box 402, Monroe, La.

Benderson, Nathan (Jun. '30), 60 Washington St., Troy, N.Y.

Benedict, Merland Henry (Jun. '30), Route 8, Medina, Ohio.

Bradford, Stuart Emerson (Assoc. M. '31), Job Engr., Raymond Concrete Pile Co. (Res., 4108 Canal St.), New Orleans, La.

Bruns, Thomas Nelson Carter (Assoc. M. '31), with Doullut & Ewin, Inc., 901 Q & C Bldg., New Orleans, La.

Buck, George Washington (M. '31), Engr. and Roadmaster, Multnomah County, 601 Court House, Portland, Ore.

Church, Earl Frank (Assoc. M. '31), Asst. Prof. Applied Math., Coll. of Applied Science, Syracuse Univ., Syracuse (Res., Parish), N.Y.

Close, Charles Edward (Assoc. M. '31), Div. Engr., National Lumber Mfrs. Assoc. (Res., 7358 North Damen Ave.), Chicago, Ill.

Clulo, James Aloisius (Jun. '31), Transitman and Draftsman, A.T. & S.F. Ry. (Res., 214 West 4th St.), Wellington, Kans.

Conlon, Willard Sylvester (Assoc. M. '31), City Engr.-Mgr. of Public Works, Town Hall, Stamford, Conn.

Conradi, Harry (M. '31), Executive Engr., State Rivers and Water Supply Comm., Treasury Gardens, East Melbourne, Victoria, Australia.

Cook, Leland Wayne (Assoc. M. '31), Asst. Chf. Engr., Metzger-Richardson Co. (Res., 6651 Ridgeville St.), Pittsburgh, Pa.

Dauchy, Edward Harold (Assoc. M. '31), (Gould & Harris) Inc., 1253 South Josephine St., Denver, Colo.

Di Domenico, Anthony Francis (Assoc. M. '31), Prin. Asst. Engr., Water Main Extensions, San. Div., Baltimore County Met. Dist., Towson (Res., 727 Aisquith St., Baltimore), Md.

Di Leo, Louis (Jun. '31), 2048 Bathgate Ave., New York, N.Y.

Dodge, Herbert Kingsbury (M. '31), Senior Design Engr., Bridge Dept., Allegheny County (Res., 221 North Ave., Emsworth, Bellevue P.O.), Pittsburgh, Pa.

Dunham, James Waring (Jun. '31), U.S. Junior Engr., Vicksburg Engr. Dist., Box 667, Vicksburg, Miss.

Folsom, James Forrest (Jun. '31), Asst. Engr., Met. Dist. Water Supply Comm., Box 195, Holden, Mass.

Foster, Lafon Allen John (Jun. '30), 59 North 11th St., Newark, N.J.

Frick, Walter Hiram (Assoc. M. '31), Cons. Structural Engr., (Architectural), 824 Rebecca Ave., Wilkinsburg, Pa.

Gialdini, Gene John (Jun. '30), Rodman, Big Four R.R., Terre Haute, Ind. (Res., 121 North Elmira St., Athens, Pa.).

Gowdy, Joseph Scott (Jun. '31), Care, New Mexico Constr. Co., Gallup, N. Mex.

Gross, Dwight David (M. '31), Chf. Engr., Board of Water Commrs., Box 629, Denver, Colo.

Hansell, Elmer Ellsworth, Jr. (Assoc. M. '31), Estimator and Designer, John H. Wickersham (Res., 624 West Chestnut St.), Lancaster, Pa.

Hart, Harold Carter (Jun. '30), 33 Washington St., Forestville, Conn.

Hester, Elmer Webb (Jun. '31), Draftsman and Office Asst., State Highway Dept. (Res., 1920 Ave. N), Lubbock, Tex.

Hicks, Ralph Comstock (Jun. '31), City Engr. (Res., 311 Perry St.), Albion, Mich.

Hinckley, Horace Parker (Jun. '31), Care Am. Concrete Pipe Co., Box 444, Phoenix, Ariz.

Horney, William Johnston, Jr. (Jun. '30), Care Nashville Bridge Co., Nashville, Tenn.

Justice, Robert Joseph (Assoc. M. '31), Res. Engr., State Highway Comm. (Res., 1824 Chickasaw St.), Topeka, Kans.

Kay, Haward Paul (Assoc. M. '31), Res. Engr., Hawley, Freese & Nichols, Box 1869, Fort Worth, Tex.

Landsem, Peter Thronaes (Assoc. M. '31), Asst. Engr., The National Committee on Wood Utilization, Dept. of Commerce (Res., 3609 Military Rd.), Washington, D.C.

Law, John Anthony (Jun. '31), Junior Topographic Engr., U.S. Geological Survey, Washington, D.C.

McConnell, Otto Faber (Assoc. M. '31), Chf. Engr., Lowensohn Constr. Co., Inc. (Res., 3557 Glencairn Rd.), Cleveland, Ohio.

Mitchell, William Johnston (Assoc. M. '31), Designer, Eng. Dept., Bethlehem Mines Corporation (Res., 625 Third Ave.), Bethlehem, Pa.

Munroe, James Edward (Jun. '31), with Munroe & Westcott, Inc. (Res., 130 North Washington St.), North Attleboro, Mass.

Padronaggio, Frank Paul (Jun. '30), 1951 West 7th St., Brooklyn, N.Y.

Pennock, Lewis "Dock" (Jun. '31), Asst. City Engr., Box 160, Hutchinson, Kans.

Perkins, Rupert Gerard (Assoc. M. '31), Field Engr., H. S. Ferguson & Co., 200 Fifth Ave., Room 1303, New York, N.Y.

Porter, Rufus Clemmens (M. '31), Agt., Ann Jordan Game Preserve, Inc., Kellyton, Ala.

Potter, Grant Hamblett (Assoc. M. '31), Supt., Munroe & Westcott, Inc., 292 Ohio Ave., Providence, R.I.

Proctor, Thomas White (Assoc. M. '31), 9 Massachusetts Ave., Boston, Mass.

Rideout, Frank Dudley (M. '31), Contr. Mgr., Am. Bridge Co., 1450 Rockefeller Bldg., Cleveland, Ohio.

Roberts, Fredrick Carlyle, Jr. (Jun. '31), Office Engr., Water Dept. (Res., 925 North Tyndall Ave.), Tucson, Ariz.

Seidensticker, William John (Jun. '31), Senior Asst. Engr., Div. of Sewerage and Sewage Disposal (Res. 544 Bulen Ave.), Columbus, Ohio.

Shelt, Millard Filmore (Affiliate '31), Pres. and Gen. Mgr., Virginia Culvert Corporation; Pres., Highway Products & Mfg. Co.; Pres. and Gen. Mgr., The Ohio Corrugated Culvert Co., Box 70, Middletown, Ohio.

Siegler, George (Assoc. M. '31), Pres. and Gen. Mgr., Geo. Siegler Co., 26 Journal Sq., Jersey City, N.J.

Skelton, Ray Hamilton (M. '31), Associate Prof., Univ. of Maryland, College Park, Md.

Spencer, Charles Brennard (Jun. '31), Topographical Draftsman, U. S. Dist. Engr's Office (Res., 4929 Forbes St.), Pittsburgh, Pa.

Summers, Glenn Lewis (Jun. '30), Chairman M. of W., N.Y.C.R.R. (Res., 220 West 107th St., Apartment 1), New York, N.Y.

TOTAL MEMBERSHIP AS OF JUNE 6, 1931

Members	5,858
Associate Members	6,303
Corporate Members	12,161
Honorary Members	16
Juniors	2,683
Affiliates	134
Fellows	6
Total	15,000

No. 507-A
INVAROD

A Precise Rod for Everyday Leveling

The GURLEY INVAROD

The Gurley INVAROD is a patented leveling rod, different from any other extension rod, or any other rod having a graduated metal face. It is the only rod which combines the accuracy of a single length of invar tape, with the convenience of the extension rod.

Stock wooden leveling rods, certified by the U. S. Bureau of Standards as being perfectly graduated, have been kept under observation by Gurley both in laboratory and field, and exhibit a change in length with change in humidity. Thus a perfectly graduated rod may be 0.014 feet shorter when used in Phoenix, Arizona, than if used in Seattle, Washington. No practical way of preventing this is known.

Gurley INVAROD of Constant Length.

Graduations are on an invar tape 1 inch wide and 12 feet long, under constant spring tension. Invar steel has long been used for steel tapes, because temperature corrections are negligible. The coefficient of expansion of the invar steel used by Gurley is 0.0000008 per degree Fahrenheit. Humidity changes, of course, have no effect.

Extends to 12 Feet, Closes to 7 Feet.

This represents a big advance in leveling rod construction. Heretofore invar rods, such as used by various departments of the U. S. Government and other precise mapping organizations, have been of long, one-piece construction. The Gurley INVAROD retains the continuous tape feature of these precise rods, and adds the convenience of the usual extension rod.

No Errors from Jarring.

When reading "high-rod," wooden rods must be fully extended and clamped to a definite setting. If jarring slips the clamp, all readings are in error. This cannot occur with the Gurley INVAROD, since the rod face is continuous from the foot of the rod.

Useful Where Headroom Is Limited.

Gurley INVAROD does not need to be fully extended for reading "high-rod." Raise it only enough to get a reading.

Can Be Used Plain or with Target.

Graduations are clean cut, of the usual Philadelphia type, reading to feet, tenths, and hundredths of a foot. The rod can thus be read directly with ease. Where vernier readings to thousandths are desired, either a plain, or micrometer setting target with vernier, can be supplied. On "high-rod," no errors can occur from improper clamping of the target, as all readings are made from the face of the rod.

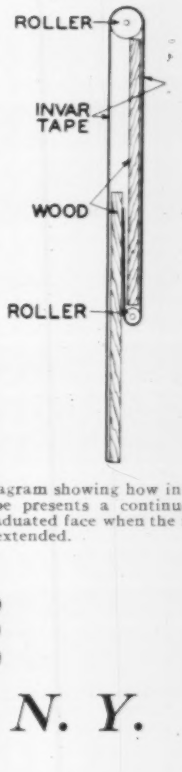


Diagram showing how invar tape presents a continuous graduated face when the rod is extended.

PRICES

No. 507-A with micrometer target,	$25.00
No. 507-B with plain target,	22.00
No. 507-C without target,	19.00

W. & L. E. GURLEY, *Troy, N. Y.*

Established 1845

New York City Sales Office, 49 Chambers Street

Tillson, Harold Luther (Assoc. M. '31), Chf. Engr., Am. Vibrolithic Corporation, 109 Eighth St., Des Moines, Iowa.

Ward, Philip Henry (Jun. '31), 421 Kimball Ave., Westfield, N.J.

Wilder, Glenn Safford (Jun. '31), Insp., Plant Dept., Western Union Telegraph Co., New York, N.Y. (Res., 138 Ferris Pl., Westfield, N.J.)

Membership Transfers

Brockway, Waldo Emerson (Assoc. M., '28; M., Mar. '31), Superv. Engr., Univ. of Colorado (Res., 845 Fifteenth St.), Boulder, Colo.

Conner, Carlton Nudd (Assoc. M., '14; M., May '31), Engr., Executive, Am. Road Builders' Assoc., 938 National Press Bldg., Washington, D.C.

Diamant, Albert (Assoc. M., '21; M., Apr. '31), Howard Beach, N.Y.

Greey, Elmer Bloomfield (Jun. '26; Assoc. M., May' 31), Chf. Engr. and Director, Matthews Constr. Co., Inc., Box 315, Princeton, N.J.

Henning, Harvey Sydney (Jun. '29; Assoc. M., Feb. '31), Chf. Engr., Henry A. Mentz & Co., Inc., Box 52, Kenner, La.

Hidalgo, Rafael Alberto (Jun. '28; Assoc. M., Feb. '31), Civ. Engr., Casilla 979, Panama, Panama.

McWilliams, Douglas Edmund (Jun., '25; Assoc. M., May '31), Vice-Pres. and Mgr., The Roaring Creek Water Co. (Res., 130 East Sunbury St.), Shamokin, Pa.

Moore, Norman Robert (Jun. '28; Assoc. M., Jan. '31), Asst. Engr., Dayton Morgan Eng. Co., Chamber of Commerce Bldg. (Res., 641 Snow Hill Boulevard), Springfield, Ohio.

Pierce, Herbert Ralph (Jun. '26; Assoc. M., Dec. '30), Asst. Engr., Tela R.R. Co., Tela, Honduras (Res., 1612 Forty-fourth St., N.W., Washington, D.C.).

Saunders, Sanford William (Jun. '22; Assoc. M., Apr. '31), Chf. Draftsman, Red Oak Bridge & Iron Works (Res., 303 Joy St.), Red Oak, Iowa.

Thompson, Philip West (Jun. '27; Assoc. M., Apr. '31), Chf. of Survey Party and Draftsman, The Southern Sierras Power Co. (Res., 4850 Somerset Drive), Riverside, Calif.

Reinstatements

Insley, William Henry, M., reinstated June 3, '31.

Stafford, Julian Tate, Jun., reinstated May 19, '31.

Deaths

Adams, Edward Dean. Elected F., Mar. 31, 1891; died May 20, 1931.

Bailey, Frank Harrison. Elected M., Jan. 14, 1918; died Apr. 29, 1931.

Clarke, St. John. Elected Jun., Sept. 5, 1888; M., June 1, 1904; died May 22, 1931.

Cykler, Emil Frank. Elected Jun., Oct. 31, 1911; Assoc. M., Mar. 13, 1917; Apr. 25, 1931.

Elwell, Charles Clement. Elected M., July 1, 1891; died May 21, 1931.

Leland, George Herbert. Elected Jun., Mar. 2, 1887; M., Feb. 1, 1893; Feb. 11, 1931.

Reimer, Frederic Adams. Elected Assoc. M., Apr. 6, 1909; M., Mar. 2, 1915; died May 18, 1931.

Stevens, Frank Stoddard. Elected M., Oct. 3, 1883; died May 26, 1931.

Tuska, Gustave R. Elected Jun., Mar. 6, 1894; Assoc. M., Jan. 1, 1896; M., Nov. 2, 1900; died May 28, 1931.

Walker, John Simpson. Elected M., Jan. 5, 1881; died May 12, 1931.

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1931 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Men Available

Engagement Desired; M. Am. Soc. C.E.; desires position in major or minor executive capacity; at present devoting experience, initiative, resourcefulness, and energy to plant operation, publicity achievement, business management, contact missions, sales development, projection promotion, field construction, and general contracting. Familiar with steel products, construction materials, and equipment. Available on short notice. C-9265.

Engineering Executive; M. Am. Soc. C.E.; 25 years engineering, executive, and construction experience, in municipal, highway, and allied lines. Responsible position desired, preferably in Middle States. Available on short notice. C-8700.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 39; married; Pennsylvania license; university graduate; 17 years experience in design, construction, surveying, railroad station buildings, warehouses, viaducts, subways, bridges, tunnels, earthwork, rockwork, railroads, cableways, highways, electric power plants, foundations, retaining walls, concrete, steel, and timber structures, and apartment, tall office, and industrial buildings. Location, East. C-7836.

Civil Engineer; Jun. Am. Soc. C.E.; graduate, 1930; now instructor in civil engineering, Rensselaer Polytechnic Institute. Interested in heavy construction, hydraulic works, subways, buildings, foundations, and their design. Wishes to establish connection with company engaged in such work. Available June 16. C-9322.

Engineer; Assoc. M. Am. Soc. C.E.; Michigan registration; 28 years experience in design and construction of railroad, municipal, irrigation, bridges, power plants, hydraulics, industrial plants, commercial buildings, docks, concrete and steel structures, and difficult foundations. Available to take charge of a project from preliminary investigations to completion. Location immaterial. C-9294.

Structural Engineer; M. Am. Soc. C.E.; experienced designer, estimator, and salesman of structural steel and ornamental iron, both riveted and welded. B-7445.

Civil Engineer; Jun. Am. Soc. C.E.; age 23; graduate in civil engineering; desires position related to structural design. Experience: 2 years drafting and surveying; 1 year instructor in civil engineering. Location, immaterial. C-9375.

Construction Engineer; Assoc. M. Am. Soc. C.E.; 44; married; 18 years experience in general engineering and building construction. Design and supervision, reinforced concrete and structural steel, investigations, reports, and appraisals in general, civil, hydraulic, and mechanical engineering; 4 years in Philippines and China. Location, anywhere, but California preferred. C-1250-4-A-34. San Francisco.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 28; married; New Jersey license; speaks French; 7 years active engineering experience in field and office, design and construction of sewerage systems, sewage treatment plants, water works, tunnels. Good personality; excellent references. Location immaterial. C-2600.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 30; graduate, 1924; 7 years thorough experience all phases of design and construction of reinforced concrete and steel highway bridges in the United States and Central America; able to plan and direct work; working knowledge of Spanish; available immediately; location immaterial; excellent references. C-9343.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 41; married; registered engineer, State of Florida; 10 years experience highways, surveys, plans, construction; 7 years experience with Pennsylvania Railroad, maintenance, and construction; 7 years municipal and 3 years city engineer. Desires position highway department, railroad, or contractor; available at once. Location, anywhere in United States. C-9367.

Engineer Salesman; M. Am. Soc. C.E.; long experience in structural and architectural engineering; 7 years selling securities for prominent engineer, bankers; would like selling job; has own car. C-9368.

Assistant Civil Engineer; Assoc. M. Am. Soc. C.E.; 32; married; registered civil engineer; graduate, California Institute of Technology. Experienced in reinforced concrete, sewage and storm water pumping plant, and large conduit design. Desires position with large manufacturer, consulting engineer, or contractor with a future. Pacific Coast, Southern California, preferred. C-9372-315-A-9. San Francisco.

Civil Engineer; Assoc. M. Am. Soc. C.E.; Cornell graduate, 39; practice covers 15 years general experience in mechanical and civil engineering; design and construction of industrial buildings, office buildings, warehouses, power house, substations, transmission lines; engineering studies of water works; investigations and reports; heavy foundations—pile, open caisson. Desires executive position with leading architects, engineer, or contractors. Good personality. B-9576.

Mathematician; Assoc. M. Am. Soc. C.E.; 44; married; engineer with unusual ability in simplification of computations for practical use; solicits assignments by correspondence; formulas evolved from observed data; nomographic charts prepared. Has M.S. degree and 20 years general engineering experience. C-9378-97-A-1.

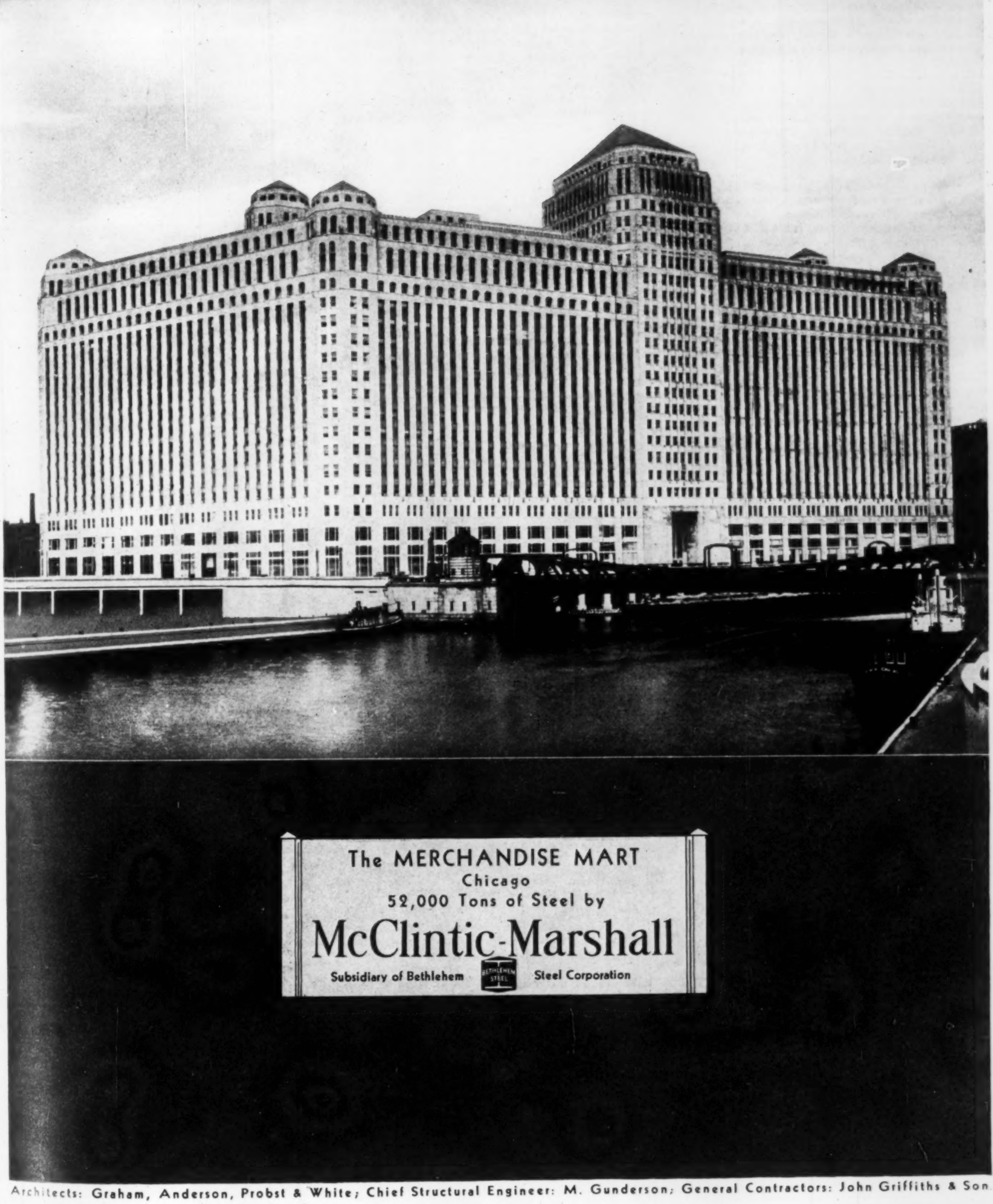
Hydro-Electric Engineer; Assoc. M. Am. Soc. C.E.; 33; married; 9 years entirely devoted to water power developments; 2 years construction, followed by 7 years on design, estimating, economical studies, and reports; 2 years as squad boss. Can furnish references from well known engineers who were former employers. Available July 1. Location, anywhere. C-9380-315-A-11. San Francisco.

Civil Engineer; Jun. Am. Soc. C.E.; 27; married; graduate in civil engineering; 6 years experience building construction as field engineer and assistant superintendent on some of largest building operations in New York City. Superintendent in construction of office building. Varied experience, from foundations to finish, on theaters, clubs, and hotels. Desires position of similar nature in New York City or vicinity. C-3263.

Engineer; Jun. Am. Soc. C.E.; married; 29; B.S. Degree Civil Engineering; 12 years experience building construction; desires position with steel contractor as engineer or estimator; with general contractor as estimator; or salesman for building material. Has contact with architects and builders in northern New Jersey. C-9340.

Construction Engineer; M. Am. Soc. C.E.; with 22 years experience in large-scale rock excavation, pile driving, railroads, concrete and steel construction, industrial installations, hydroelectric and steam power plants, sewers and water

THE LARGEST BUILDING IN THE WORLD



The MERCHANDISE MART
Chicago
52,000 Tons of Steel by
McClintic-Marshall
Subsidiary of Bethlehem Steel Corporation

Architects: Graham, Anderson, Probst & White; Chief Structural Engineer: M. Gunderson; General Contractors: John Griffiths & Son

works. Is open for engagement. Foreign languages spoken: Spanish, German, French. B-4743.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 5 years experience various kinds map drafting. Chief draftsman regional planning association. Assisted with studies in: highways, by-pass routes, traffic, parks, recreational areas, population forecasts, uses of land, sewage, water. Charge enlarging, bringing up-to-date 24 U.S.G.S. maps. Experience on aerial map control. C-9419.

CONSTRUCTION SUPERINTENDENT, ENGINEER; Assoc. M. Am. Soc. C.E.; married; 22 years varied experience, building railroads, sewers, buildings, tunnels, reinforced concrete structures; docks, piers, piling, cofferdams, hydrographic, topographic, and property surveys, factory buildings, and machinery installation. Worked in South America, South Africa. Suitable position with reasonable pay, would go anywhere. A-359.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 27 years experience in drafting, land and topographic surveying, railroad, water supply, sewerage, irrigation, drainage and flood control engineering. Prefers vicinity of Washington, D.C., but will consider other localities. U.S. Civil Service status. A-5125.

CIVIL AND INDUSTRIAL ENGINEER; M. Am. Soc. C.E.; graduate; licensed New York and New Jersey; 20 years experience power plants, hydro-electric developments, industrial plants of all kinds, complete housing developments including all utilities. Experience covers design and construction. Has had full charge of operations. Highest references. B-2835.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; married; college graduate; desires responsible position, 10 years broad experience. Design of railroad structures, power plants, viaducts and industrial buildings. Has had experience in night college instruction. Location anywhere. Salary subordinate to opportunity. B-7338.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; 2 years graduate school of business administration; licensed professional engineer New York; 8 years experience structural steel and machinery, detailing, checking, designing, research, estimating, pricing, shop, field location, and supervision. Not employed at present; will consider anything anywhere; salary unimportant. C-1654.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 46; married; 20 years experience, irrigation, mining, extensive detail and topographic mapping, inventories and commercial reports, oil and gas industry; 12 years with a large public utility, heading department of a number of employees. Licensed engineer. C-7723.

EXPERIENCED ENGINEER; Assoc. M. Am. Soc. C.E.; university training. Railroad location, maintenance and operation; handling labor; managing sugar plantations and their railroad lines. Speaks Spanish; 6 years experience North America; 17 years in tropics. Native of United States. Used to responsibility and not afraid of hard work. Excellent references; location immaterial. C-9354.

CIVIL ENGINEER; M. Am. Soc. C.E.; 23 years experience on design and construction of steel and reinforced concrete, bridges, buildings, railroad and municipal works. Open for position as chief engineer, superintendent, or in similar capacity. B-9497.

CIVIL ENGINEER; M. Am. Soc. C.E.; broad experience; available for engagement on highway, road and bridge work, highway location, and construction. B-7788.

CIVIL ENGINEER; M. Am. Soc. C.E.; 14 years experience; just back from South America, desires responsible position, preferably on highway or railroad construction and location; has also considerable experience in general and triangulation surveys. Speaks and writes Spanish and French. Location immaterial. B-9765.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; university graduate 1928; age 28; $2^{1}/_{2}$ years experience as draftsman in bridge office; tracing, detailing, checking, and designing culverts, abutments, piers, and deck girder bridges. Speaks and writes Swedish. Available at once. Salary commensurate with experience. C-4381.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; with varied, comprehensive experience in irrigation, reclamation, highway, and farm survey work. Six years responsible charge of, and detail work in, industrial plant, building layout, design, construction, layout and installation of machinery, transmission, conveying, power plant equipment. Desires responsible position pertaining to above qualifications. C-6910.

STRUCTURAL AND HYDRAULIC ENGINEER; Jun. Am. Soc. C.E.; 27; married; graduate University of Illinois; experience, 1 year highway layout and design, 3 years hydro-electric power plant construction, $1^{1}/_{2}$ years of steam plant design. Desires permanent position with engineering or construction firm. Southwest preferred. C-3600.

CONSTRUCTION AND STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 28; University graduate; 1 year post-graduate structural engineering; 1 year railroad surveying; 1 year highway construction; 15 months Federal reclamation construction and design; 1 year oil refinery construction and design; 6 months railway signal construction; at present employed. Will go anywhere. C-7025.

INSTRUCTOR CIVIL ENGINEERING; Jun. Am. Soc. C.E.; 30; B.S. in Engineering, Princeton, 1926; New York State license; author several technical articles; chief assistant to well known consulting engineer; unusual background in underpinning, subway, and heavy construction; desires teaching position with permission to do consulting on side. C-9232.

CIVIL ENGINEER; Jun. M. Am. Soc. C.E.; graduate 1927. 19 months engineer-draftsman, bank and office building construction; 21 months civil engineer industrial plant design and survey; 5 months teaching subsequent to graduation. Prior to graduation: 2 years machine drafting, 6 months transitman subway and exposition construction. C-5086.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 87 to 89 of the Year Book for 1931. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

CONCRETE DESIGN AND CONSTRUCTION. By W. L. Webb and W. H. Gibson. Chicago, Amer. Tech. Soc., 1931. 374 pp., illus., charts, diagrs., tables, 9 × 6 in., cloth. $2.50.

This book aims to present the subject concisely and simply with emphasis upon practical matters. All aspects of concrete work are touched upon, with sufficient fullness for the ordinary requirements of the engineer and contractor. Only simple mathematics is used and the book is adapted to home study.

ENGINEERING GEOLOGY. 4 ed. By H. Ries and T. L. Watson. New York, John Wiley and Sons, 1931. 708 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth. $5.

A text book of general geology, which emphasizes the principles involved in such engineering problems as the structure of rocks in relation to tunneling and dam foundations, underground water supplies, the relation of soils to sewage disposal and water purification, the character of building stone, etc. The principal feature of this edition is a new chapter on the geology of reservoirs and dam sites.

ENGINEERING MECHANICS. By F. L. Brown. New York, John Wiley and Sons, 1931. 477 pp., charts, diagrs., 10 × 6 in., cloth. $4.

A text book for students of engineering, covering the subjects usually included in undergraduate courses. A large number of illustrative and practice problems is given.

HANDBUCH DER GEOPHYSIK. Edited by Professor Dr. B. Gutenberg. Berlin, Gebruder Borntraeger. Maps, illus., tables, 11 × 7 in., paper.

A handbook, designed to fill the need for a comprehensive work of reference upon geophysics, which will contain all the important formulas, the available numerical data, and information upon the theory and use of geophysical instruments. A chapter on building destruction and its prevention is included.

HEATING AND VENTILATION. 3 ed. By J. R. Allen and J. H. Walker. New York, McGraw-Hill Book Co., Inc., 1931. 426 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $4.

A text book for students of engineering and architecture which will also be of interest to engineers who wish a brief manual of design. The book has been thoroughly revised and considerably enlarged. Material upon air conditioning and artificial cooling has been added.

HYDRAULICS FOR ENGINEERS. By R. W. Angus. London and New York, Isaac Pitman & Sons, 1931. 304 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.50.

The methods given in this text book are those that the author has found successful during thirty years of experiment, practice, and teaching hydraulic engineering. Difficult mathematics has been avoided. All discussion of hydrostatics is omitted, the matter treated being confined to the flow of water in pipes, orifices, weirs and open channels, hydraulic turbines and centrifugal pumps, and non-uniform flow.

MATERIALS HANDBOOK. 2 ed. By G. S. Brady. New York, McGraw-Hill Book Co., Inc., 1931. 588 pp., charts, tables, 7 × 4 in., leather $5.

A volume containing brief information upon the composition and properties of abrasives, brasses, bronzes, building materials, alloys, paints, chemicals, lubricants, and similar materials used in industry. The arrangement is alphabetic and, in addition, a classified table of contents is provided. The book covers a wide range and will be a useful reference for manufacturers, purchasing agents, and others having to select and distinguish materials.

MODERN SEWAGE DISPOSAL AND HYGIENICS. By S. H. Adams. London, E. and F. N. Spon, Ltd.; New York, Spon and Chamberlain, 1930. 473 pp., illus., charts, tables, 9 × 6 in., cloth. $10.

The experience of English municipalities with various methods of sewage disposal is presented in considerable detail and occupies the major portion of this book. American work at Lawrence and Worcester is also presented, and the requirements of the Ministry of Health are given in full. A general summary of the development of sanitation is included and a chronological table of English commissions, legislation, and memorable events affecting sanitation and related questions.

POCKET BOOK OF ENGINEERING FORMULAE. 30 ed. By Sir G. L. Molesworth. London, E. and F. N. Spon, Ltd., 1931. 935 pp., diagrs., charts, tables, 5 × 3 in., leather. 6s.

A remarkable amount of information is contained in this small book, which has been popular among engineers for almost seventy years. In the present edition much new matter has been added—especially upon aircraft, gasoline engines, boilers, and gearing—and tabular matter has been corrected and brought up to date.

PRACTICAL MARINE DIESEL ENGINEERING. 2 ed. By L. R. Ford. New York, Simmons Boardman Publishing Company, 1931. 758 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $7.

In this volume construction and operation are discussed from the point of view of the practical engineer. Theoretical principles are explained briefly while the construction of the various parts of engines, the accessory equipment, and a large number of makes of engines are described in detail. A large part of the book is devoted to operation, such matters as repairs, tests, and lubrication being explained quite fully.

In DETROIT Michigan

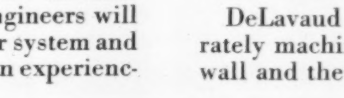
more than 800 miles of DeLavaud Pipe are now in service

Detroit is known throughout the world as the headquarters of the automotive industry. Those acquainted with the city will also tell you of its wide streets and beautiful buildings — particularly the new Masonic Temple (shown above). Detroit's city engineers will doubtless emphasize their modern water system and the marked success which they have been experiencing with deLavaud Pipe. A recent check-up shows that today 803 miles of deLavaud Pipe, in sizes from 6 to 16 inch, are in use throughout the city.

DeLavaud is the modern pipe for modern conditions. Not only is it at least 25% stronger than pit cast pipe, but it is lighter in weight and thus more economical to handle and install. DeLavaud Pipe is extremely satisfactory to cut and tap too. And it offers a greater carrying capacity for the same outside diameter.

DeLavaud Pipe is centrifugally cast in an accurately machined mold. The uniformity of the pipe wall and the even grain structure of the metal are assured by the laws of science. To improve further the toughness of the metal, every length is placed in a furnace where annealing temperatures are accurately controlled.

The deLavaud Handbook gives complete information and detailed specifications. Write for free copy.



The self-centering shoulder in the deLavaud bell eliminates the requirement of a bead. In laying deLavaud pipe it is only necessary to place the spigot of one pipe within the bell of the next, sliding the pipe forward until it rides upon the taper and automatically centers itself.

United States Pipe and Foundry Co., Burlington, N.J.

Our pipe bears the "Q-Check" trademark of The Cast Iron Pipe Research Association

Sales Offices: New York, Philadelphia, Pittsburgh, Cleveland, Buffalo, Chicago, Dallas, Birmingham, Kansas City, Minneapolis, Seattle, San Francisco, Los Angeles

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this Library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

Arches, Multiple. Theory of Multiple Reinforced Concrete Arch Bridge on Elastic Piers, H. Yu. *Assn. Chinese and Am. Engrs.—Jl.*, vol. 12, no. 3, Mar. 1931, pp. 3–23, 4 figs. Theoretical mathematical discussion of methods of determining stresses in multiple arches when any one of them is under system of external loads; excessive bending moment at pier base; practical example.

Clearances. Bridge Clearances Not Fixed Arbitrarily, L. Brown. *Eng. News-Rec.*, vol. 106, no. 19, May 17, 1931, p. 775. Chief of Engineers discusses principles of selection of bridge clearances, with special reference to proposed bridge over Hudson River at 57th St., New York City.

Concrete Arch, Testing. Laboratory Tests of Reinforced Concrete Arches with Decks, W. M. Wilson. *Univ. Ill.—Eng. Experiment Station—Bul.*, vol. 28, no. 34, Apr. 21, 1931, 100 pp., 53 figs. Behavior of concrete monolithic structures consisting of rib, spandrel columns and deck compared with behavior of similar rib without columns or deck; tests were made upon 6 arches having ribs that were identical but decks that were different; extent to which variations in deck influence behavior of structure as whole; tests made to determine effect of load and effect of abutment movements; ribs of arches had span of 17 ft. 6 in., and rise of 4 ft. $^{1}/_{16}$ in.

Design. The Development of the Bridge, S. J. Crispin, Jr. *Instn. Engrs.—Jl. and Rec. Trans.*, vol. 41, pt. 5, Feb. 1931, pp. 204–212, 7 figs. Elementary discussion of evolution of arch and truss bridges.

Funicular Railroads, Colorado. Royal Gorge Bridge and Incline Railroad, J. C. Coyle. *West. Construction News*, vol. 6, no. 8, Apr. 25, 1931, pp. 215–216, 2 figs. Methods used in construction of suspension bridge for vehicles, 1,200 ft. long and 1,053 ft. above bed of river; cables have span of 880 ft. between towers, with sag of 60 ft.; scenic incline track is 1,400 ft. long and has three rails, except at middle, where switch was installed for two cars to pass each other; two cars, carrying 21 passengers each, will be operated by 60-hp. electric motor with speed of 300 ft. per min.

Railroad Crossings, Chicago. Three-Level Grade Separation at Chicago. *Eng. News-Rec.*, vol. 106, no. 18, Apr. 30, 1931, pp. 731–734, 6 figs. Design and construction of three-level crossing in vicinity of Canal and 16th streets, which includes railroad bridge carried above street bridge, viaduct construction of unusual character, and shifting of two railroad bascule bridges to fit track rearrangements; project planned as unit; work done under heavy railway street traffic; special viaduct details.

Railroad, Suisun Bay, Calif. The Southern Pacific Company's New Martinez-Benicia Bridge, M. Noble and M. K. Wright. *Baldwin Locomotives*, vol. 9, no. 4, Apr. 1931, pp. 31–44, 22 figs. History of Overland Route of Southern Pacific Co. and events leading up to construction of Martinez-Benicia bridge; map showing location of bridge and ferry lines which preceded it; main features of steel truss railroad bridge 5,604 ft. long, with individual spans up to 531 ft. in length; construction details.

Steel Truss, Reconstruction. Reconstruction of Hawthorn Bridge, W. D. Chapman. *Instn. Engrs. Australia—Jl.*, vol. 3, no. 3, Mar. 1931, pp. 81–89, 12 figs. Description of old three-span lattice-girder bridge on masonry piers with maximum span of 150 ft.; investigation showed excellent condition of hardwood foundation piles after 73 years' service; methods adopted in underpinning masonry piers; strengthening lattice girders by electric welding; procedure control of welding; sandblasting; relief of dead load stresses; estimates of strength of welds; details of large fillet weld; tensile tests of single lap welds made on old wrought iron plates, oxy-cut edges.

BUILDINGS

Exhibition Buildings. Transport Building at Chicago World's Fair. *Eng. News-Rec.*, vol. 106, no. 19, May 7, 1931, pp. 766–767, 4 figs. Structural features of building consisting of two story rectangular portion, about 1,000 × 145 ft.; rectangular annex, 100 × 220 ft. with three-hinged arch trusses; circular tower, 200 ft. in diam. and 125 ft. high having domed roof suspended from cables attached to tall towers arranged in circle.

New York. The Empire State Building—XI, H. R. Dowswell. *Arch. Forum*, vol. 54, no. 5, May 1931, pp. 625–632, 18 figs. Materials of construction; waterproofing; general floor construction; wall construction; roofing and sheet metal; cement finish; hollow metal; marble; architectural metals; granite.

Sheet Metal Construction. The Loftiest of Man-Made Structures. *Sheet Metal Worker*, vol. 22, no. 9, May 1, 1931, pp. 238–241, 16 figs. Use of sheet metal in construction of Empire State Building, New York City.

Specifications. Assembly of Specification Data, H. R. Sleeper. *Arch. Forum*, vol. 54, no. 5, May 1931, pp. 619–621. Methods of gathering information from variety of sources to form nucleus of known data about particular job in hand; recommendations for general specification data for specific data, and for specification compilation.

Welded Steel Structures. Welding Field Joints on a Fourteen-Story Office Building, J. T. Whitney. *Am. Welding Soc.—Jl.*, vol. 9, no. 12, Dec. 1930, pp. 7–12, 5 figs. Welding operations in erection of new office building for Edison Electric Illuminating Co. of Boston; designed by Bigelow, Wadsworth, Hubbard, and Smith, Boston; sketches illustrate typical welded field connections.

Wind Bracing. Wind Stress Research on the Empire State Building. *Engrs. and Eng.*, vol. 48, no. 4, Apr. 1931, pp. VI–VII. American Institute of Steel Construction has inaugurated wind-stress research on Empire State Building which will afford some actual performance data regarding effects of wind on tall buildings. These studies can be designed and constructed so that amount of sway under most adverse weather conditions is too small to make them uncomfortable.

CITY AND REGIONAL PLANNING

Canada. New Lamps for Old in Western Canada, A. G. Dalzell. *Town Planning*, vol. 10, no. 2, Apr. 1931, pp. 44–50, 3 figs. President of Town Planning Institute of Canada discusses new methods of urban land development needed in Western Canada; social cost of past and present methods; planning of towns is stern economic necessity; bad planning means oppressive taxation and economic disaster; assessment of urban land for taxation purposes; effect of high land value on use of land for dwellings.

City Surveying. Systematized Resurveys of Cities, D. W. Bingham. *Mich. Engr.*, vol. 49, no. 1, Mar. 1931, pp. 32–36. Attention is called to main steps and processes to be employed to insure that time and money expended will provide most lasting benefit.

New Jersey. County Planning Proves Its Value, R. Van Nest Black. *Am. City*, vol. 44, no. 5, May 1931, pp. 116–118, 2 figs. Discussion of New Mercer County, N.J., plan in particular and of county planning in general; parks and parkways; present and future uses of plan; aid to economy in county expenditures; keeping plan up to date.

Vancouver, B.C. A Plan for the City of Vancouver, British Columbia, J. A. Walker. *Town Planning*, vol. 10, no. 2, Apr. 1931, pp. 35–43, 11 figs. Abstract of report containing chapters upon major streets, transit, transportation, railway and harbor sections, public recreation, civic art, and zoning.

CIVIL ENGINEERING

Chicago. The Engineer's Contribution to Chicago, E. S. Nethercut. *West. Soc. Engrs.—Jl.*, vol. 36, no. 2, Apr. 1931, pp. 124–126. Some achievements of Chicago engineers; Chicago skyscraper developed; system of water tunnels; new tunnel being built with area equal to 16-ft. circle, using new materials and methods, but fundamentally same as Chesbrough's first intake tunnel; Chicago bridges; almost universal type of bascule bridge developed by Chicago engineers; flow of Chicago River has been reversed; location and relocation, construction, and reconstruction of railroads.

CONCRETE

Aggregates, Impurities. Deleterious Substances in Concrete Aggregates, F. C. Lang. *Nat. Sand and Gravel Bul.*, vol. 12, no. 4, Apr. 1931, pp. 17–20, 6 figs. Effect of deleterious substances in gravel pebbles to be used as coarse aggregate in concrete; shale freezing and thawing; effect of expansion of unsound coarse aggregate in concrete.

Construction. Manufacturing Concrete of Uniform Quality, W. M. Hall. *Am. Soc. Civil Engrs.—Proc.*, vol. 57, no. 5, May 1931, pp. 675–697. Practice and methods used by U.S. Government engineers in construction of 9 locks and dams in Ohio River between Louisville, Ky., and its mouth; task required more than 750,000 cu. yd. of concrete; specifications; inspection; cement tests; sieve analysis of sand and gravel.

Forms. Details of Movable Forms and Their Operation, R. T. McKay. *Concrete*, vol. 38, no. 5, May 1931, pp. 33–36, 6 figs. Making up, raising forms, and jacking up forms; moving jack screws. (Continuation of serial.)

Osage River. Fast Concreting Speeds Completion of Osage River Power Project. *Construction Methods*, vol. 13, no. 5, May 1931, pp. 38–43, 12 figs. Description of project; general construction plan; material-handling plant; sand and gravel plant; excavating equipment; construction bridge; gantry travelers; material storage; concrete-placing records; extensive use of cellular sheet-pile coffer-dams.

Ready-Mixed. Pre-Mixed Concrete in Dallas-Fort Worth District. *Rock Products*, vol. 34, no. 9, Apr. 25, 1931, pp. 101–104, 13 figs. Descriptive notes on structures, equipment, and operation of several plants.

Shrinkage. Rule for Predicting Concrete Shrinkage. *Eng. and Contracting*, vol. 70, no. 4, Apr. 1931, pp. 91–92, 3 figs. Factors upon which amount of shrinkage of concrete and mortar depends; convenient rule for predicting shrinkage terms of cement and water content; conclusions relating to shrinkage given in Maney's paper in amplified form.

Specifications. Simplification of Coarse Aggregate Specifications in the St. Louis District. *Rock Products*, vol. 34, no. 9, Apr. 25, 1931, pp. 64–65. Summary of coarse aggregate specifications; specifications for coarse aggregate for plain and reinforced concrete; general requirements grading requirements; physical requirements.

Stresses. An Inquiry into Stresses in Reinforced Concrete Slabs and Their Correct Reinforcement, B. N. Dey. *Assn. Engrs.—Jl.*, vol. 4, no. 2/3, June/Sept. 1930, pp. 52–57 and (discussion) 57–58, 6 figs. Attempt is made to analyze mathematically various stresses induced in slab conclusions are borne out by actual experiments carried out at various European Universities; appendix contains note on theories of Bach Grashof, and Rankine and French Government rule, relating to strength of reinforced-concrete slabs.

Subway Construction, New York City. Building New York's Subways—VIII. *Construction Methods*, vol. 13, no. 5, May 1931, pp. 62–65, 19 figs. Description of truck mixers and agitators supplying subway concrete.

1909 1931

HERCULES STEEL PILES

22 Years of Construction Experience in

FOUNDATIONS

Time is the Builder of Experience. In the 22 years of our experience we established three fundamental foundation principles.

Reliability	The foundation must sustain the building beyond the possibility of failure.
Economy	The foundation must be put in economically.
Time Saving	The foundation must be put in quickly, in order that the owner may quickly capitalize on his investment.

PROOF. A foundation to meet any difficult requirement.

UNDERPINNING & FOUNDATION CO., INC.
Engineers and Contractors
342 Madison Avenue, New York

CONSTRUCTION INDUSTRY

Costs. Current Construction Unit Prices. *Eng. News-Rec.*, vol. 106, no. 19, May 7, 1931, pp. 784–785, 5 figs. Unit prices bid and description of following: vitrified sewers for Braintree, Mass., in open cut 15,250 lin. ft., 8-in. to 36-in. sewers, to depths 8 to 12 ft.; Boston traffic tunnel, $5,696,510, extending from North Square in Boston to corner of Decatur and London Streets in East Boston, distance of 4,875 ft.; tunnel is to be circular, 31 ft. in diam. with $21^{1}/_{2}$ ft. roadway; wood-pile pier with concrete deck, New York, N.Y.

Laws and Legislation. Some Recent Points Decided in Engineering Law, H. Braasch. *Eng. News-Rec.*, vol. 106, no. 19, May 7, 1931, pp. 768–769. Decisions reached in cases tried in higher federal courts and in state supreme courts; highway board responsible for inaccuracies of estimates and borings; advances by owner to builder; standard of conduct in emergency; noncompliance with bonding requirement of code; obligation surviving completion and payment; identity of materials in lien or bond.

Records. Charting the Progress of Job Costs, W. E. Ramsey. *General Bldg. Contractor*, vol. 2, no. 5, May 1931, pp. 30–32, 2 figs. Outline of graphical system based on principle that any item may be charted from final estimate as line, horizontal projection of which is percentage of progress and vertical projection; money expended.

DAMS

Concrete, Construction. Cofferdams and Stream Control at Jordan Dam, Alabama, L. Warren. *Eng. News-Rec.*, vol. 106, no. 20, May 14, 1931, pp. 804–808, 7 figs. Report on construction of curved, gate-controlled, overflow concrete dam, over 100 ft. high, on Coosa River; building crib dams 40 ft. high; sealing construction joints; closure methods for stream-control openings; closure procedure; concreting; concrete joint construction in power house.

Concrete, Egypt. The Nag Hammadi Barrage, Upper Egypt, A. R. Ellison. *Instn. Civil Engrs.—Minutes of Proc.*, Paper no. 4816, 1930–1931, 28 pp., 7 figs. on supp. plate. Report of construction at stony gate concrete dam consisting of 100 six-meter bays; with piers about 13 m. high, costing 1,945,000 Egyptian pounds.

Construction. Cofferdamming the Columbia at Rock Island—A Real Construction Battle. *Eng. News-Rec.*, vol. 106, no. 18, Apr. 30, 1931, pp. 716–719, 6 figs. Turning Columbia River from its channel for foundation construction work on Rock Island dam, being built for Washington Electric Co., near Wenatchee, Wash.; designing and building two timber-crib structures with aggregate length of about 1,500 ft. and maximum height of 58 ft.; river bottom sounded in sub-zero weather; timber cribs held and sunk in 15 m.p.h. stream; unwatering 25 acres in 5 days; scale model of every crib was made for framing crew.

Earth, Leominster, Mass. Antiquated Reservoir Rebuilt by Water-Works Employees, W. G. Classon. *Water Works Eng.*, vol. 84, no. 9, May 6, 1931, pp. 561–562, 7 figs. Reconstruction of old first dam 600 ft. long, built in 1853; methods and cost of work.

Spillways, Gates. Gate Handling at Calderwood Dam, A. J. Ackerman. *Eng. News-Rec.*, vol. 106, no. 19, May 7, 1931, pp. 754–757, 8 figs. Two gantry cranes and improved mechanical arrangements permit one-man operation of stony gates on 200,000 sec-ft. spillway; 25 gates are each 26 ft. long and 20 ft. high, and are built up of structural shapes; maintaining thinnest practicable sheet of water by opening larger number of gates only fraction of their height before flood required any gate to be opened to maximum position; dogging system; time cycle for handling gates; crane power supply.

FLOOD CONTROL

Vermont. Report of Advisory Committee of Engineers on Flood Control. *Pub. Service Commission, State of Vermont*, Dec. 15, 1930, 23 pp., 1 supp. map. Study of flood control on principal rivers of state carried out during past 3 years; channel improvement recommendations; report of committee for 1928 on flood of November 1927; final program for storage and power sites; legislation regarding storage reservoir projects; data on storage and power projects; estimated costs.

FLOW OF FLUIDS

Measuring Instruments. The Measurement of Water, H. B. Millard. *Soc. Engrs.—Trans.*, 1930, pp. 196–216 and (discussion) 216–229, 16 figs, partly on supp. plate. Indexed in Engineering Index 1930, p. 744, from Surveyor, Nov. 7, 1930, and Contract Rec., Dec. 10, 1930.

FOUNDATIONS

Piles, Concrete. The Economic Design of Reinforced Concrete Piles, J. P. Porter. *Concrete and Constr. Eng.*, vol. 26, nos. 3 and 4, Mar. 1931, pp. 203–209, and Apr., pp. 237–243, 4 figs. March: Site conditions; pile dimensions and stresses; steel stresses; compression stress in concrete; modular ratio; shear stresses in concrete; lateral reinforcement of piles. April: Loads and forces sustained by piles; dimensions and reinforcement; handling stresses; size of links; driving stresses; short-column and long-column loads; selection of foundation.

Piles, Wooden. An Opinion on the Safest and Least Expensive Foundation Piling Adapted to Shanghai Conditions, E. J. Muller. *Eng. Soc. of China—Proc.*, vol. 28, 1929–30, pp. XLIX to LVI and (discussion) 1–25L, 2 figs. Economy of sawing of Oregon 12-in. by 12-in. piles into two wedge-shaped ones.

HYDRO-ELECTRIC POWER PLANTS

Niagara Falls. Preservation of Niagara's Beauty. *Contract Rec.*, vol. 45, no. 16, Apr. 22, 1931, pp. 474–475. Abstract of final report of joint commission; construction of submerged deflecting weirs recommended; temporary withdrawal of additional water for power development is suggested.

INLAND WATERWAYS

Canal Locks, Gates. Self-Staunching Roller Sluice Gate, J. Chanteux. *Engineering*, vol. 131, no. 3405, Apr. 17, 1931, pp. 512–513, 3 figs. Because of size and high lift of new locks on Charleroi-Brussels canal, it was important to reduce leakage losses of sluices; attention was paid to design of sluice gates which would remain tight over long periods of service; sluice illustrated is supported by four rollers, mounted eccentrically on short shafts to which are keyed levers, coupled to arms on strong shaft extending across top of gate; results of tests; advantages of design. Indexed in *Engineering Index* 1930, p. 259, from Annales des Travaux Publics de Belgique, Aug. 1930.

United States. Development of Inland Water System, U. V. Wilcox. *Timberman*, vol. 32, no. 3, Jan. 1931, pp. 40 and 43, 3 figs. Lumber among many commodities to benefit by extension of American barge lines; review of recent developments in inland waterways; map illustrating principal waterways of United States.

Transportation on Inland Waterways—I, E. C. Powers. *Mar. Rev.*, vol. 61, no. 4, Apr. 1931, pp. 68–73, 1 fig. Discussion of improvement of 15 important inland waterways; improvement of channels; savings in freight resulting; commerce moving over rivers and canals; future work; proposed and projected waterways.

Transportation on Inland Waterways—II, E. C. Powers. *Mar. Rev.*, vol. 61, no. 5, May 1931, pp. 22–28 and 56, 8 figs. Development of modern river boats from early types; lines and equipment operating; various services described; discussion of freight savings.

IRRIGATION

India. Some Notes on the Irwin Canal from the Krishnarajasagara, R. K. R. Seshachar. *Mysore Engrs. Assn.—Bul.*, vol. 8, no. 2, Apr. May, and June 1930, pp. 1–270, 9 figs, 13 supp. plates. Outline and discussion of combined hydro-electric and irrigation project to command irrigable area of 400,000 acres, necessitating construction of gravity dam about 150 ft. high; data for design of principal structures and cost estimates.

LAND RECLAMATION AND DRAINAGE

California. Reclamation and Development in the Sacramento-San Joaquin Delta, G. A. Atherton. *Agricultural Eng.*, vol. 12, no. 4, Apr. 1931, pp. 129–130, 3 figs. Review of 70 years' progress in development peat lands along eastern part of Bay of San Francisco. Before Am. Soc. Agric. Engrs.

Economic Problems of Western Reclamation, J. W. Haw. *Agric. Eng.*, vol. 12, no. 4, Apr. 1931, pp. 123–128, 8 figs. General optimistic discussion ending with conclusion that program of bringing in more irrigated lands in anticipation of demands of growing country is and will be, for many years to come, sound economics for West. Before Am. Soc. Agric. Engrs.

MATERIALS TESTING

American Society for Testing Materials. A Review of Society Activities During 1930. *Am. Soc. Testing Matls.—Bul.*, no. 48, Jan. 30, 1931, pp. 1–3 and 6–10. Standardization and research activities covering iron and steel, non-ferrous metals and alloys, non-ferrous screen wire cloth; cement, clay products, and gypsum; drain tile, hollow tile, brick, and refractories; concrete and concrete aggregates; paints, petroleum products, and naval stores; shipping containers, timber and fire tests; bituminous waterproofing and roofing materials; insulating materials; rubber products and textile materials; slate and building stone.

Metals. Metallurgical Creep, A. C. Hinton. *Engineer*, vol. 151, no. 3930, May 8, 1931, p. 506, 2 figs. Proposed formula connecting rate of tensile creep and stress, is offered by author in hope that someone may find rational basis for his empirical formula.

Road Materials. Filler Material Requires Study for Proper Oil-Mix Road Design, T. E. Stanton. *Eng. News-Rec.*, vol. 106, no. 17, Apr. 23, 1931, p. 700, 1 fig. Report on recent laboratory studies carried on by California State Division of Highways; characteristics of material passing 20-mesh sieve; its oil capacity; material included limestone dust, portland cement, hydrated lime, silica dust, talc, pumicite, and diatomaceous earths.

MUNICIPAL ENGINEERING

Parks, New York State. Jones Beach State Park. *Am. City*, vol. 44, no. 5, May 1931, pp. 126–129, 7 figs. Description of Jones Beach State Park of Long Island State Park Commission, New York; during 1930 season, there was total attendance of 1,376,000 with 256,412 bathhouse patrols, and 223,945 cars parked; system of parks and parkways comprising 15,000 acres.

Parks, State. The Position of State Parks as a National Asset for Recreation, H. Evison. *World Ports*, vol. 19, no. 5, Mar. 1931, pp. 673–678 and (discussion) 678–681. It is claimed that possibilities of real national system of parks, that will perform broad national purpose, lie in extension of State park system. Before Am. Shore and Beach Preservation Assn.

PORTS AND MARITIME STRUCTURES

Harbor Improvements, Financing. Allotments for Rivers and Harbors Announced by Secretary of War. *Mar. News*, vol. 17, no. 11, Apr. 1931, pp. 58–60. Allotments to works of river and harbor improvement made by Secretary of War upon recommendation of Chief of Engineers; recommendations total nearly $53,000,000, and development of projects is expected to aid in further relief of unemployment.

Lake Charles, La. Inland Seaport Created at Lake Charles, La. *Eng. News-Rec.*, vol. 106, no. 19, May 7, 1931, pp. 773–774, 4 figs. Description of new port developed mainly by local interests, reached by 75-mi. ship channel built with government assistance; port facilities at Lake Charles; wharf and freight sheds.

Naval Aspects. Adequate Ports as a Naval Asset, M. W. Powers. *World Ports*, vol. 19, no. 6, Apr. 1931, pp. 748–758 and (discussion) 758–762. Need of navy in line of ports; need of more extensive port developments; avoiding centers of congestion; marine terminal national enterprise; need of Federal support of ports; port authorities position. Before Am. Assn. Port Authorities.

Port Terminals. Relations Between Railways and Sea Ports. *Int. Congress Assn.—Bul.*, vol. 13, no. 4, Apr. 1931, pp. 282–302. Discussion by section of layout of maritime stations; arrangements of outer and inner basins so that most efficient layout of sidings may be provided for working them; operating and rate-fixing methods; loading and discharging appliances.

Port Terminals, Operation. Marine Terminal Design from the Operating Point of View—III, F. R. Harris, H. E. Stocker, W. B. Ferguson, and R. F. Bessey. *Mar. Rev.*, vol. 61, no. 5, May 1931, pp. 38–40, 5 figs. Question of ship's tackle vs. cranes; essential that proper facilities be provided for personnel; essentials for keeping port time at minimum; provisions for security of life and property.

Shore Protection. The Work of the Corps of Engineers on Shore and Beach Preservation, L. Brown. *World Ports*, vol. 19, no. 5, Mar. 1931, pp. 633–641. Announcement of appointment on Sept. 18, 1930, of Beach Erosion Board; duties are to furnish such technical assistance as may be directed by Chief of Engineers in conduct of studies undertaken; to review reports of investigations; make personal examination of localities under investigation, all with view of deciding effective means of preventing erosion of shores of coastal and lake waters by waves and currents. Before Am. Shore and Beach Preservation Assn.

RAILROADS, STATIONS, AND TERMINALS

Hamilton, Ont. Canadian National Railways New Station at Hamilton. *Can. Ry. and Mar. World*, no. 398, Apr. 1931, pp. 197–198, 2 figs. Outstanding constructional and design features of new station; building interior; track and grade crossings.

ROADS AND STREETS

Construction. Settling Swamp Fills by Blasting, J. A. Williams. *Eng. News-Rec.*, vol. 106, no. 17, Apr. 23, 1931, pp. 687–689, 3 figs. Methods used to stabilize highway embankments in southern New Jersey for new road; need for rigid pavements made it essential to obtain solid fills carried down to solid bottom beneath mud; dynamite found very effective; settling existing fills under traffic; salvaging damaged concrete pavement; equipment used.

Design. Increasing the Capacity of Highways, S. D. Waldon. *Traffic Regulation*, vol. 1, no. 2, Dec. 1930, pp. 51–56 and 74–75, 6 figs. Factors to be considered in future planning of highways; trend toward greater widths; benefits of 120-ft. roads.

Visibility on the Highway. *Traffic Regulation*, vol. 1, no. 4, Feb. 1931, pp. 144 and 148–149, 1 fig. Minimum visibility requirements for road design developed by Committee on visibility of American Road Builders Assn.

Cairo
Memphis
New Orleans

© Airview by Airmap Corporation of America, N. Y.

On the Mississippi

K & E

**Internal Focusing Transits
Levels and Alidades**

Large numbers of these surveying instruments are serving the U. S. Engineers in laying out their plans for the Mississippi River flood control program.

TRADE MARK

KEUFFEL & ESSER CO.

HOBOKEN, N. J.

NEW YORK CHICAGO ST. LOUIS SAN FRANCISCO MONTREAL

Foundations. Economic Thickness of Foundations, R. M. Green. *Can. Engr.*, vol. 60, no. 17, Apr. 28, 1931, pp. 27–28 and 54. Thickness of wearing course; construction of road subgrade; thickness of foundations; black base construction; macadam bases. Before Ninth Annual Asphalt Paving Conference.

Highway Administration, United States. Highway Policies in Several States. *Pub. Works*, vol. 62, no. 5, May 1931, pp. 37–38 and 74. Excerpts from governors' annual messages concerning low-cost roads, gasoline taxes, state aid for city streets, finances, unemployment, and other features of highway progress.

Improvement. Roadside Beautification, J. Downer. *Roads and Streets*, vol. 71, no. 4, Apr. 1931, pp. 128–131, 5 figs. Methods for counteracting roadside defacement and unsightliness within and without right-of-way boundaries; what can be done within existing rights-of-way; intelligent forestry work now essential; signboards now on defensive; filling-station problem; recreational areas and roadside stopping places; Westchester County type of parkway; parkway influence on land utilization.

Low Cost. Economic Features of the Bituminous Type of Road, C. L. McKesson. *Crushed Stone Jl.*, vol. 7, no. 2, Feb. 1931, pp. 9–14 and (discussion) 14–15, 11 figs. Experience obtained in West on low-cost type of pavement; low cost roads must solve problem; bituminous types and their economic advantages; bituminous types for heavy duty, for light and medium traffic; non-skid surfaces; typical examples of economical construction; stage construction over yielding foundation; "armorcoating" or "retreading" metalled roads; reconstruction of old pavement; salvaging of gravel roads.

The Use of Sand and Gravel in Bituminous Work on Rural Highways, H. S. Perry. *Nat. Sand and Gravel Bul.*, vol. 12, no. 4, Apr. 1931, pp. 21–22 and 27. Low-cost mixed tops; mixed-in-place, built-up penetration; straight penetration; and pre-mixed types of road surfaces.

Surface Treatment. Kerosene Non-Skid Treatment on Asphaltic Concrete Pavements, W. K. Beckham. *Roads and Streets*, vol. 71, no. 4, Apr. 1931, pp. 121–122, 5 figs. Report on experimental road surface treatment in Florence and Dillon counties in South Carolina.

Surface Treatment and Dust Prevention, W. J. Emmons. *Highway Engr. and Contractor*, vol. 38, no. 13, Apr. 1, 1931, pp. 41–44, 7 figs. Practical discussion of practice of several state highway departments; practical information.

SEWERAGE AND SEWAGE DISPOSAL

Disposal Plants. Industrial Sewage Disposal, S. Jackson and W. Garner. *Indus. Chemist*, vol. 7, no. 75, Apr. 1931, pp. 166–168, 3 figs. Sludge disposal; artificial drying; sludge trenching and digestion; hot pressing. (Concluded.)

Operation and Control of Sewage Treatment Plants—III. *Municipal Sanitation*, vol. 2, no. 5, May 1931, pp. 242–243. Imhoff tanks; "foaming" in Imhoff tanks; dosing apparatus; trickling or sprinkling filters.

Disposal Plants, Colorado. Small and Compact Sewage Works for Aurora, Colo., J. W. McCullough. *Eng. News-Rec.*, vol. 106, no. 18, Apr. 30, 1931, p. 742, 1 fig. Description of modern plant, including grit channel, settling tank, equipped with mechanically operated skimmer and sludge scraper, separate sludge-digestion tank, provided with sludge agitator, sludge-drying bed, effluent aerator, and chlorinator; sedimentation and separate sludge digestion with mechanical equipment and effluent aerated and chlorinated; plant is designed for future population of 5,000.

Disposal Plants, Rockville Center, L. I. Percolation Beds Provide Disposal of Sewage-Plant Effluent, C. Potts. *Eng. News-Rec.*, vol. 106, no. 17, Apr. 23, 1931, pp. 684–686, 4 figs. Description of Rockville Center, L. I., sewage treatment plant to serve population of 14,000; natural sands of Long Island permit percolation at maximum rate of 10 m.g.d. per acre; glass-covered sludge-drying beds have high efficiency; aeration tanks are equipped with detachable diffuser units.

Pumping Plants. Some Essential Points on Sewage Pumping Stations, C. Kelsey Mathews. *Municipal Sanitation*, vol. 2, no. 5, May 1931, pp. 241–242, 2 figs. Where pumps are required; design of stations; equipment; capacity; automatic operation sewage pumps. Before Missouri Water and Sewerage Conference.

STRUCTURAL ENGINEERING

Chimneys, Wind Pressure. Wind Pressure on Large Chimneys, H. L. Dryden and G. C. Hill. *Commercial Standards Monthly*, vol. 7, no. 6, Dec. 1930, pp. 178–179, 4 figs. Wind-tunnel measurements; suction effects on chimneys; type of distribution changes with wind speed; model tests not reliable in this case; special stack built for outdoor measurements; power-plant stack used for measurements; tests indicate effect of length-diameter ratio.

SURVEYING

Aerial Photography, Mapping. Planetabling from the Air, O. M. Miller. *Geographical Rev.*, vol. 21, no. 2, Apr. 1931, pp. 201–212, 7 figs. Method of oblique aerial surveying as means of making small-scale contour maps at relatively low cost.

Aerial Surveying. Aerial Photographic Survey and Mapping, T. Abrams. *Mich. Engr.*, vol. 49, no. 1, Mar. 1931, pp. 37–41. Michigan is first state to use aerial surveys in connection with its state highway work; and invariably they show decided saving in both time and cost over ground surveys; for comparative figures on large areas of 1,000 sq. mi. or over, costs for ground surveys range from 20 to 50 cents per acre for topographic information, as compiled by U. S. Geological Survey at scale of 1,000 ft. = 1 in., whereas, cost for aerial survey ranges from 4 to 5 cents per acre at this scale. See also discussion by H. Brightman, pp. 42–43.

Surveying Instruments, Transits. Inquiry into the Relative Accuracy of the Optical Micrometer Theodolite, H. Briggs and W. W. Connor. *Min. Inst. of Scotland—Trans.*, vol. 51, part 4, Feb. 18, 1931, pp. 59–68 and (discussion) 68–72, 8 figs. Description of several makes of optical-micrometer theodolites; Rand theodolite; centering, description of observations; average error; procedure and results; sighting and reading errors; speed and serviceableness.

Triangulation. City Triangulation, D. H. Nelles. *Engineering*, vol. 131, no. 3405, Apr. 17, 1931, pp. 505–508, 14 figs. Necessity for using methods of primary accuracy in city triangulation is shown and also of designing traverse net at same time that triangulation net is designed and stations located.

TRAFFIC CONTROL

Highway Traffic Surveys. Rural Highway Traffic Volume Survey, M. Halsey. *Traffic Regulation*, vol. 1, no. 5, Mar. 1931, pp. 161–168, 181, 183 and 184, 10 figs. Necessity for and methods of making traffic volume survey.

Street Traffic Control. The Economic Justification of Traffic Improvements in Cities, H. S. Simpson. *Engrs. and Eng.*, vol. 48, no. 3, Mar. 1931, pp. 64–70. Humanitarian and economic phases of situation; each is susceptible of subdivision into two important factors, rural problem and city problem; rural-suburban conditions; effects of congestion in cities; measures for congestion relief; elevated highways in cities; traffic signaling; staggered hours; parking. Before joint meeting of Engrs. Club and Am. Soc. Civil Engrs.

TUNNELS

Sewer Tunnels, Canada. Large Tunnel Sewer in Ottawa. *Contract Rec.*, vol. 5, no. 17, Apr. 29, 1931, p. 506. Engineering data on King Edward sewer, 2,450 ft. long, 8 ft. by 8 ft. 10 in. in section, driven through solid rock.

Sewer Tunnels, South Africa. A Fine Engineering Feat. *S. African Engr. and Elec. Rev.*, vol. 21, no. 155, Mar. 1931, pp. 27 and 29, 4 figs. Descriptive note on Malvern-Kensington sewer tunnel forming part of sewer system of eastern suburbs of Johannesburg; tunnel is 4.75 ft. in diam., 3,900 ft. long, 90 ft. in depth; Greathead shield method adopted.

Vehicular. Detroit and Canada Vehicular Tunnel. *Can. Engr.*, vol. 60, no. 16, Apr. 21, 1931, pp. 11–15 and 53, 7 figs. Description of construction features and ventilating system; construction of tunnel divided into several sections; leveling device; preparing tubes for submersion; connecting tubes under water; trench backfilling; hydraulic tunneling shield; box-type subway.

Water Supply. New York Aqueduct Construction—Safe or Unsafe Tunneling, H. W. Richardson. *Eng. News-Rec.*, vol. 106, no. 18, Apr. 30, 1931, pp. 739–741, 4 figs. Fatalities on 20-mi. Yonkers-Brooklyn tunnel work lead to press charges that contractor disregards safety precautions; investigation disproves charges; elaborate safety system in use; bad rock conditions encountered; analysis of fatality record; methods of handling bad roof; underground magazines for dynamite storage; styles of permament steel-roof supports.

WATER PIPE LINES

Corrosion. Pipe-Line Currents and Soil Resistivity as Indicators of Local Corrosive Soil Areas, E. R. Shepard. *U.S. Bur. Standards—Jl. Research*, vol. 6, no. 4, Apr. 1931, pp. 683–708, 17 figs. partly on supp. plates. Extensive investigation on a dozen pipe lines ranging from Gulf-Coast to Southern Kansas revealed apparent correlation between pipe-line currents, soil resistivity, and corrosion; galvanic currents of measurable magnitudes were found flowing on all pipe lines; abrupt changes in resistivity and unusually low resistivity were found to be significant with respect to corrosion; soils having resistivity of 500 ohm-cm., or less, were invariably found to be highly corrosive.

Emergency Construction. Rapid Installation of San Francisco's Emergency Water Supply. *Pub. Works*, vol. 62, no. 5, May 1931, pp. 23 and 64. Insuring against shortage by purchasing water from East Bay Municipal Utility District and pumping it through 13 mi. of pipe; plan involved construction of about 35,000 ft. of 44-in. × $^{5}/_{16}$-in., and 52,000 ft. of 36-in. × $^{1}/_{4}$-in. welded or lock-bar pipe, with alternative of 46-in. and 38-in., if riveted pipe were used.

WATER RESOURCES

Supply, Drought Regions. Water Supplies in the Drought Regions. *Nat. Fire Protection Assn.—Quarterly*, vol. 24, no. 4, Apr. 1931, pp. 382–386, 4 figs. Few of cities and towns that have suffered water shortage are mentioned; drought contributing factor in increased fire losses of 1930, may also be reflected in fire loss figures for 1931; wisdom of general policy of municipal authorities in providing large water reserves.

Supply, United States. Surface Water Supply of the United States 1927: North Atlantic Slope Drainage Basins. *U.S. Dept. of Interior—Water Supply Paper*, no. 641, 1931, 188 pp.

Surface Water Supply of the United States 1927: Ohio River Basin. *U.S. Dept. Interior—Water-Supply Paper*, No. 643, 1931, 216 pp., 1 fig.

Surface Water Supply of the United States 1927: V, Hudson Bay and Upper Mississippi River Basins. *U.S. Geol. Survey Water-Supply Paper*, no. 645, 1931, 115 pp., 1 fig. Three of series of 14 reports presenting results of measurements of flow made on streams in United States during year ending Sept. 30, 1927.

WATER TREATMENT

Analysis. Interpretation of Water Analysis, D. S. McKinney. *Indus. and Eng. Chem.—Analytical Edition*, vol. 3, no. 2, Apr. 15, 1931, pp. 192–197, 2 figs. Equilibrium considerations determining activities and concentrations of ions; defects in methods now in use for determining alkaline ions in water; two methods of calculating anions of carbonic and orthophosphoric acids are presented in which relations between pH value, dissociation constants of these acids, and dissociation constant of water are used to calculate concentrations of various alkaline ions at 25 deg. cent.

Practical Chemistry of Water Conditioning—3, W. W. Robinson, Jr. *Inst. Petroleum Technology*, vol. 8, no. 5, Apr. 1931, pp. 173–178, 12 figs. Causes of foaming; advantages of evaporators; corrosion; determination of hydrogen-ion concentration; boiler embrittlement.

Coagulation. Sodium Aluminate Coagulation in Water Treatment, G. J. Fink. *Water Works Eng.*, vol. 84, no. 9, May 6, 1931, pp. 563–564 and 596, 5 figs. Use of sodium aluminate as alkaline coagulant and its employment in all branches of water purification; use of sodium aluminate in filtration; advantages as used in water softening; internal treatment. Before annual conference Penn. Water Works Operators' Assn.

Taste and Odor Removal. The Elimination of Tastes from Drinking Water, F. J. Spry. *Cornell Civil Engr.*, vol. 39, no. 7, Apr. 1931, pp. 174–177 and 193. Causes of taste odors; effect of ordinary processes of water treatment; permanganate treatment; ammonia-chlorine process; super-chlorination process; activated carbon process; cost of taste elimination.

Treating Taste and Odor in Public Water Supplies, N. J. Howard. *Contract Rec.*, vol. 45, no. 17, Apr. 29, 1931, pp. 501–503 and 506, 1 fig. Chlorine tastes; due to microscopic organisms; Superchlorination; formation of chloramines; activated carbon process.

WATER WORKS ENGINEERING

Management. New York Water Department Solves Many Operating Problems, W. W. Brush. *Water Works Eng.*, vol. 84, no. 8, Apr. 22, 1931, pp. 499–500, and 528, 1 fig. Purchase of land for protection of water supply from pollution; patrol of watersheds; bathing, boating, fishing, and ice cutting; sewage collection and disposal; chlorination of stream flow; taxes; reforesting; copper-sulphate treatment; weed growth on exposed areas; cleaning of interior; stopping leaks; crossing by other structures; aerators; chlorination; reservoirs; new mains installed by use of corporate stock funds.

Operation. Use of Indicating and Recording Instruments in Facilitating Water Works Operation, W. D. Rolfe. *Water Works Eng.*, vol. 84, no. 9, May 6, 1931, pp. 567–568 and 588 and 591, 4 figs. Value and need of instruments in power installations; essential features of rapid sand filters, methods of control; flow meters for measuring wash water; controlling filter effluent; rate of flow and loss of head measurement; measuring input and output of plant; instruments for measuring chemical treatments; importance of pressure records; instruments for remote control stations.

Water Law. Legal Phases of Municipal Water Storage, M. Lindsey. *Am. Water Works Assn.—Jl.*, vol. 23, no. 4, Apr. 1931, pp. 514–520. Discussion of problem as to whether junior direct appropriator may invade senior storage appropriation; recent court decisions.